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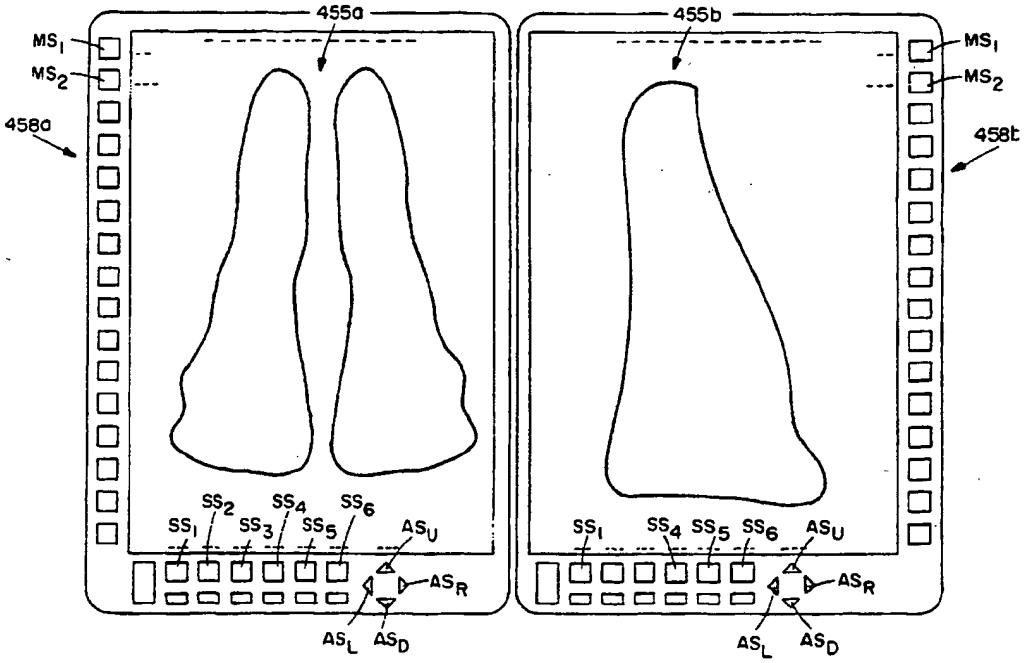

(57) **Abstract**

A picture archiving and communication system (PACS) stores, maintains, and displays medical image data for intensive care patients. The system provides rapid access to medical image data so that Intensive Care Unit physicians and radiologist have around-the-clock instant access to medical images. The medical images are displayed on medium or high resolution switch-driven monitors coupled to image review stations. Each image review stations can support up to two monitors, which simultaneously display different images. The display on a first monitor is controlled by touch-sensitive input switches on the first monitor. The display on a second monitor is controlled by the display on the first monitor and touch-sensitive input switches on the second monitor.

USER INTERFACE FOR PICTURE ARCHIVING AND COMMUNICATION SYSTEM

Background of the Invention

A radiology department in a hospital or other medical clinic is typically responsible for the production, review, and storage of radiological images, such as x-ray images of patients. Various personnel are used in the radiology department to fulfill these responsibilities. For example, after an image is generated, a clerk or technician must label the image with pertinent identification and assign the image to a radiologist for a first reading. The technician can also determine which, if any, other images are pertinent to the reading of the current image and provide those other images along with the current image. After a radiologist has reviewed a set of images, which form a radiology study of a patient, the images are stored in a library that is maintained by film librarians. The film librarians are not only responsible for the orderly storage of the images but also for the retrieval of images upon request.

Images are retrieved for various reasons, including review of a patient, a comparison study between images in different studies for the same patient, a training session, or any combination thereof. In a comparison study, it is advantageous to view together those images taken at a same angle of the patient and to be able to proceed through a series of images from one study in parallel with a similar series of images from another study. Thus, placement of images for review is an important task that is performed by a film clerk or technician.

Actually examination and review of the images are performed by a radiologist. During a radiological review, the radiologist can take certain measurements

of image parts, enlarge desired images to focus on a certain aspect thereof, and otherwise manipulate the images to obtain the sought and necessary information. Furthermore, a radiologist generates a report on the set of images in a radiology study. Radiologist typically require film to be interpreted in the radiology department.

At the same time, physicians working in an Intensive Care Unit (ICU) typically require images of each patient held in intensive care to be available in the ICU. Consequently, an x-ray film taken in the ICU is delivered to radiology for development. The image from the developed film is then carried to the ICU from the radiology department. Such an arrangement requires the radiologist to travel to the ICU to interpret films stored there, which is not the best use of a radiologist's skill and time.

Currently, most of the foregoing tasks are performed manually. Some image enhancing devices are available for displaying images in a desired manner. These devices still require manual retrieval, selection, and placement of the images. In addition, there is usually only one copy of an image available for use in the hospital. Hence, for the most part a radiologist is dependent on a manual, multi-personnel system that does not allow much flexibility nor does it promote work efficiency.

Summary of the Invention

Accordingly, there is a need for an automated system for storing, examining, and reviewing medical images. Furthermore, there is a need for an intuitive user interface to facilitate use by hospital personnel.

The present invention provides a data processing system that automates the storage, and viewing of

medical images. The medical images are digitally stored within a computer storage device as medical image data. The medical images of various patients can be digitized from conventional images, such as x-ray images, or generated by clinical imaging systems such as a CAT scan, magnetic resonance imaging (MRI), nuclear imaging (NI), or other computed radiography (CR) systems. The medical image data is stored in an image server as a digital representation of the medical image data. Each image is classified in the image server according to the particular patient. Each patient can have a plurality of studies, each study in turn having a plurality of images. The image server also stores text data and voice data associated with any patient, study, or image.

An image entry station is coupled to the image server. The image entry station is used to enter the digital representations of medical images into the image server. The image entry station can be a film digitizer station for electronically digitizing conventional radiographs and entering the digitized radiographs into the image server. The image entry station can also be a computed radiography station.

A patient census station is also coupled to the image server. The patient census station is used to enter and maintain text data related to each patient. The text data includes patients demographics, patient location, and patient discharge information.

An image review station is also coupled to the image server. The image review station is used to access medical images and text data stored in the image server. Voice data can also be entered into the image server using the image review station. The image review station is further used to display the medical images and text data to a user in response to a set of

commands. Typically, the image review station is located remote from the image entry station.

The image review station comprises a first monitor having touch-sensitive input switches. The input switches of the first monitor are used to enter a first set of user commands. The user selects a first display image to be displayed on the first monitor using the input switches on the first monitor. In response, the first monitor displays the first display image.

The image review station can further comprise a second monitor also having touch-sensitive input switches. The input switches of the second monitor represent a second set of user commands. The second monitor displays a second display image in response to user commands entered from the first monitor and the second monitor. The second display image is displayed simultaneously with the first display image.

In a preferred embodiment, the monitors are cathode-ray tube (CRT) displays coupled to a radiographic image data processing unit having a video source for displaying radiographic images to a user. The monitor comprises a plurality of touch-sensitive input switches disposed on the perimeter of the display. The input switches accept user input and are coupled to the data processing unit. The input switches comprise softkeys and hardkeys. The softkeys are defined based on the state of the display and the hardkeys have fixed definitions. There are a first and a second group of softkeys. The first group of softkeys are registered to a display list, each of the input switches in the first group of softkeys is used to select an item from the display list. Each of the second group of softkeys are registered to a display function for controlling the state of the display.

Typically, there are a plurality of image review stations located remote from the image entry station. Each image review station provides simultaneous access to a display of stored medical image data. For example, there can be one image review station in each ICU and one image review station in the radiology department of a hospital. Such an arrangement permits physicians in an ICU and radiologists in a radiology department to view and analyze the medical image simultaneously.

In a preferred embodiment of the invention, a user enters user commands using touch-sensitive input switches on a first monitor. An ICU is selected by the user or by default to the user's current ICU. A list of patients within the ICU is displayed to the user. The user selects a patient from the patient list using the input switches. A list of studies for the selected patient is displayed to the user. Each study is a sequence of images. The user selects a study from the study list using the input switches. An image from the selected study is displayed to the user. Initially, the image is the first sequential image in the study. A list of images in the current study is displayed simultaneously with the displayed image. In a dual-monitor embodiment of the invention, the next sequential image in the study is displayed on a second monitor.

An imager is also coupled to the image server. The imager produces hardcopy printouts of medical images. In a preferred embodiment, the imager is a laser imager that prints on film.

In a preferred embodiment, an optical image local area network (LAN) is used to couple the various component together. The LAN permits the image review stations to be located remote from the image server.

For example, a central image server located in a hospital can be used by satellite clinics, each satellite clinic having an image review station. The satellite clinics can across-town, across-country, or around-the-world from the image server.

Brief Description of the Drawings

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings, in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. 1 is a block diagram of a preferred embodiment of a picture archiving and communication system.

FIGs. 2A-2B are schematic block diagrams of a patient demographics database maintained in the image server 30 of FIG. 1. FIG. 2A is a schematic block diagram of a patient information record. FIG. 2B is a schematic block diagram of patient study records.

FIGs. 3A-3D are block diagrams showing preferred embodiments of configuring the invention. FIG. 3A illustrates a high-resolution system with wet-image reading in radiology. FIG. 3B illustrates a high-resolution system with wet-image reading in the intensive care units. FIG. 3C illustrates a medium-resolution system with wet-image reading in radiology. FIG. 3D illustrates a medium-resolution system with hard copy review in radiology.

FIG. 4 is a block diagram of an image server 30 of FIG. 1.

FIG. 5 is a block diagram of an image review station 40 of FIG. 1.

FIGs. 6A-6B are pictorial representations of image review station monitors 458 of FIG. 5. FIG. 6A illustrates a single-monitor image review station. FIG. 6B illustrates a dual-monitor image review station.

FIG. 7 is a high level flow diagram of the menu structure of the image review station.

FIGs. 8A-8B are pictorial representations of a patient list display. FIG. 8A is a pictorial representation of a displayed patient listing screen on a single-monitor image review station. FIG. 8B is a pictorial representation of a displayed patient listing screen on a dual-monitor image review station.

FIGs. 9A-9B are pictorial representations of a study list display. FIG. 9A is a pictorial representation of a displayed study listing screen on a single-monitor image review station. FIG. 9B is a pictorial representation of a displayed exam listing screen on a dual-monitor image review station.

FIGs. 10A-B are pictorial representations of an image list display. FIG. 10A is a pictorial representation of a displayed image listing screen on a single-monitor image review station. FIG. 10B is a pictorial representation of a displayed image listing screen on a dual-monitor image review station.

FIG. 11 is a pictorial representation of a displayed image listing screen and an exam listing screen on a dual-monitor image review station.

FIG. 12 is a pictorial representation of a displayed image listing screen and a comparison image listing screen on a dual-monitor image review station.

FIG. 13 is a pictorial representation of a displayed menu screen on a single-monitor image review station.

Detailed Description of a Preferred Embodiment of the Invention

The present invention is a computer system that makes it easier for personnel in Intensive Care Units (ICU) and radiology departments to work together. The invention is an electronic imaging system that makes radiographic images available to ICU physicians and to radiologists at the same time. Radiographic images start in radiology, where they are digitized and stored in a computer system according to a preferred embodiment of the invention. These digitized images are immediately available in both the radiology department and in the ICU.

In a preferred embodiment, the system of the invention is a computer network intended to deal with a specific operational problem existing in most hospitals. One problem solved by the invention is that ICU physicians require that radiographic images be in the ICU at all times, while radiologists require that radiographic interpretation be done in the radiology department. Patients in an ICU typically receive one portable chest radiographic per day, and in many instances more than one. To ensure patient care, it is vital that radiographic images be available in the ICU at all times. Usually, the radiologist has to travel to the ICU to interpret films, which is not the best use of a radiologist's skill and time. Another problem is that in many hospitals, the film is processed in the radiology department, which means that the film needs to be removed from the ICU. The present invention solves these problems.

For radiology to deliver a timely interpretation, it is currently necessary for the radiologist to physically travel daily to the ICU, a most inefficient use of the radiologist time. The problem is additionally exacerbated by the fact that, in many hospitals the film processors are located only within the radiology department, which encourages hospital personnel to remove the films from the ICUs, where the films belong.

The conflict between the two groups is easily resolved by the present invention. According to a preferred embodiment of the invention, radiographs remain in the ICU and radiologists remain in the radiology department. The conflict is over when and where the images get interpreted by radiology. The problem is solved by the present invention by making a clinically useful image available electronically in the ICU. Thus, the requirement that the physical films remain in the ICU is eliminated.

FIG. 1 is a block diagram of a preferred embodiment of a picture archiving and communication system (PACS) according to the present invention. Basic patient demographics (e.g., name, medical record number, patient location, etc.) are entered at a patient census station (PCS) 10. Radiographic films are converted to digital images at an image entry station (IES) 20. The image entry station 20 can be a film digitizer station (FDS) for scanning radiographic films into the system or a computed radiography station (CRS) that scans computed radiography images into the system. Digital images and patient demographics are stored in an image server 30. The digital images and patient demographics are made available to a number of image review stations (IRS) 40. The image review stations 40 are preferable located in the ICU suites,

where the image is displayed on a computer screen for review by physicians. Any image entered into the system can be printed to film using an imager 50.

In a preferred embodiment, the PACS handles medical image data associated with ICU patients. Because there are a limited number of ICUs in a hospital, each having a small limited capacity, the PACS is optimized to provide rapid access to medical image data. The system supports a plurality of patient census stations 10, and a plurality of image entry stations 20 (each of which can be a film digitizer station or a computed radiography station). The system also supports a plurality of image review stations 40. In a preferred embodiment there are two different types of image review stations, those supporting a very high resolution display and those supporting a medium resolution display.

In a preferred embodiment of the invention, the system follows the client-server model, where the image server 30 contains the servers that the clients (i.e., image review stations 40, patient census station 10, and image entry station 20) can access. The servers are databases with patient location, exam, image, system audit tracking, system event monitoring, and system error information. Patient image data is stored on image caches composed of magnetic disk-farms, tightly-coupled to a 100 megabit optical LAN. This LAN allows for approximately a two second access to any image from an image review station 40. The image server 30 also contains a patient demographic database, a study database, and an image database. Additionally, the image server 30 contains the overall system control software that manages the system application. Patient and exam information and image data gathered at the patient census stations 10 or at the image entry

stations 20 are collected and stored in the image server 30 in a relational database 300.

In general, the system will allow the following function:

1. Collecting ICU patient demographics and location via an interactive terminal-based application;
2. Collecting of ICU patient radiographic images via a film-digitizer or a computed radiography (CR) unit;
3. Storing the radiographic images and demographic data in a short-term archive;
4. Allowing hard copy generation of images via an imager 50;
5. Distributing image and demographics via high speed LANs to the image review stations 40 located in the ICU's.

It is recognized that users of the system will be hospital personnel with little training in computer use. The lack of computer training exasperates the resistance to digital image technology in hospitals. It is a goal of the invention that the image review stations 40 be sufficiently intuitive to use that little or no training is required. It is another goal that the system be highly reliable and easy to use. The probable users for each component of the system are:

1. Image Review Station 40:
   ICU attending physicians, radiologists, residents, interns, and nursing staff;
2. Patient Census Station 10:
   Nursing and clerical staff;

3. Image Entry Station 20:
   Radiology technicians;
4. Image Server 30:
   Radiology computer support staff, and
   ICU nursing staff.

As shown in FIG. 1, the image server 30 is the hub of the network and all other components are connected to the image server 30. The image server 30 controls the overall activity of this system. In addition, the image server 30 functions as the repository for the diagnostic and usage data. The image server 30 provides the following functions:

1. Coordinating overall system activity;
2. Maintaining and storing a patient demographic database;
3. Maintaining and storing of a radiographic image database;
4. Maintaining and storing of a voice annotation database;
5. Permitting attachment of mixed-class image review stations 40;
6. Supporting attachment of patient census stations 10;
7. Supporting an imager capable of image printing;
8. Managing storage assets and operational purging of unwanted images and patient records;
9. Compiling, and optionally printing, system usage and utilization reports (e.g., images stored, images recalled, images printed, and total patients in system);

10. Supporting a system administrators console for periodic maintenance and status investigations;
11. Containing system level diagnostic and consistency software;
12. Storing images transmitted from image entry stations 20;
13. Retrieving and transmitting images to image review stations 40 and imager 50 upon request;
14. Managing queued printing to the imager 50;
15. Managing transactions event logging to record image digitizing, printing, and deletion;
16. Managing internal system integrity checking and logging, and listing patient census entries and images received in data base;
17. Managing system error logging for corrective maintenance;
18. Managing an accounting log, log to record printing, logins, reboots;
19. Maintaining system security entries for controlled access to the image server 30 and for voice entry;
20. Supporting a magnetic tape system for initial installation of system and application software, installation of major maintenance releases and system software upgrades as applicable and for system backups;
21. Supporting a set of maintenance functions to allow initial configuration of intensive care unit types and bed numbers.

A demographic database contains demographic information associated with each patient. FIGs. 2A-2B are schematic block diagrams of a database 300 (FIG. 1)

for a patient. A patient information record 310 comprises fields for identifying the patent, including a patient name field 311, a medical record number field 312, a date of birth (DOB) field 313, and a sex field 314. The patient information record 310 further comprises treatment fields, including a clinical history field 315, a referring physician field 316, a requesting physician field 317, an ICU tape 318, a bed location field 319, and a field 320 to indicate the number of studies associated with the patient.

Each patient can have a plurality of study records 380, one study record 380 for each image study of the patient. A study record 380 comprises for each study, a date of image acquisition field 381, an image label field 382, a study description field 383, a textual image description 384, a voice annotation field 385, and a textual annotation field 386.

Each patient census station 10 is a free standing computer station to be used by clerical and nursing staff. Patient census stations 10 allow for patient demographics, patient location, and patient discharge information to be entered into this system. Patient census stations 10 are preferable located at a nursing station shared by several ICUs within a particular ICU. There typically is only one patient census station 10 per ICU floor. The functions provided by the patient census station 10 are;

1. Allowing basic patient demographics to be entered or modified;
2. Allowing for the location (i.e., ICU name and bed identification) of the patient to be supplied or modified;
3. Allowing a specific radiographic image to be printed on the imager 50;

4. Allowing for the automatic printing of all images to an imager 50 upon patient discharge from the ICU;
5. Allowing for the addition of a text and a voice note to a particular patient exam.

There are two types of image entry stations 20. Film digitizer stations and computed radiography stations store images into the system. In a preferred embodiment of the invention, the system can have a plurality of film digitizer stations, a plurality of computed radiography stations, or a mixture of each type. Both types of stations work the same way. The only difference is that in the film digitizer station, the images start out on film, and on the computed radiography station, the images start out on a computed radiography unit.

When a radiology department processes images, technicians use a film digitizer station or a computed radiography stations to digitize the images into the system. A scanner reads existing film images and translates those images into a digital image made up of pixels. In a preferred embodiment, there are two hundred pixels per inch (i.e., 200 dpi) and each pixel can be one of 4096 shades of gray (i.e., 8-bit intensity resolution). After the technician scans a set of images, the station sends the image to the image server 30 over a high speed network. A display on the station lets the technician preview the images before sending them to the image server 30 to ensure that the images were scanned correctly.

In a preferred embodiment of the invention, the film digitizer stations and the computed radiography stations consist of a Macintosh computer with a gray scale monitor. In particular, the film digitizer

station acquires images through a Lumisys scanner, and the computed radiography station acquires images through a Fuji AC1+ computed radiography unit. The following functions are provided by computed radiography stations:

1. Entering of ICU patient plane films via a computed radiography unit;
2. Collecting film demographics via keyboard input (posteroanterior (PA), lateral (LAT), KUB - i.e., a study);
3. Collecting patient demographics via keyboard input;
4. Allowing for computed radiography image review prior to acceptance into the clinical image data base;
5. Allowing for computed radiography images to be flipped and rotated into standard orientation prior to entry into the clinical image database;
6. Supporting multiple images per study;
7. Configurable with a plurality image input devices.

The acquired images are stored into the image server 30 in an image database 390 (FIG. 1).

Image review stations 40 allow for the display of previously entered electronic equivalent radiographs to be displayed on monitors. In a preferred embodiment of the invention, the monitors are monochrome CRT displays. Typically, image review stations 40 are deployed in the ICUs. However, an image review station 40 can be located in the radiology department as well. The following functions are provided by the image review stations 40:

1. Supporting at least four monitor configurations:
   single-monitor 870x1152 portrait (1K),
   dual-monitor 870x1152 portrait (1K),
   single-monitor 1800x2250 portrait (2K),
   dual-monitor 1800x2250 portrait (2K);
2. Providing physicians with a touch membrane user interface for ease of use;
3. Normally displaying a default ICU's patients;
4. Allowing, via the user interface, for the selection of the ICU, the patient, the patient's particular study, and individual images from the study;
5. Allowing the pixel intensity mapping (i.e., image windowing) to be rapidly changed by the user.
6. Providing for image zooming on a 5-quadrant basis (i.e., upper left, upper right, lower left, lower right, and center) for 1K monitors;
7. Allowing for voice annotations to be added to any study;
8. Allowing for the playback of any associated voice annotations with the name of the recorded radiologist displayed on the screen;
9. Allowing the display of text notes upon the display screen, where these notes have been entered at a patient census station 10;
10. Displaying more than one study at a particular image review station 40.

To convey the images to the image review stations 40 from the image server, an optical image local area network (LAN) is employed in a preferred embodiment of

the invention. More particularly, a star-topology LAN operates at a signaling rate at about 100 megabits/second over 62.50/125 micron multi-mode fiber optic cable, illuminated at a wavelength of 650 nanometers. The optical image LAN provides 4 megabytes/second optical transmission image data from the image server 30 to the image review stations 40, with end-to-end transmission checking and verification. An Ethernet interface is used for the image review station 40 command and control, image transmissions from the image entry stations 20, and for patient and exam information to and from the patient census station 10.

In addition to the above identified features, a preferred embodiment of the invention has remote diagnostic capability. The system allows remote query of system activity and status via a modem that is integral to the image server 30. The system allows for remote minor software updates. The system also provides remote visibility to the patient census station 10, the image entry stations 20, the image server 30, and the image review stations 40. In addition, remote access to diagnostic and usage logs is provided.

FIGs. 3A-3D illustrate sample configurations for a preferred embodiment of the invention. By way of illustration, relevant departments are shown dispersed about a multi-story hospital building. It is understood however, that the particular floors and location of departments is not critical. Although the various departments are shown within a single hospital building, the various departments can be dispersed across a number of buildings without affecting the scope of the invention. Indeed, the various

departments are not required to be within the same hospital.

FIG. 3A illustrates a high-resolution configuration with wet reading of images in radiology. The radiology department is shown on the first floor. The image server 30 and the imager 50 are located in radiology. Also located in the radiology department is a high-resolution image review station 40a, where a radiologist can dictate wet readings from soft copy of images for the ICU exams. The ICUs are shown located on the seventh and eighth floor. In the ICUs, a clinician, while reviewing a patient's images on a image review station 40, can listen to the associated report entered by the radiologist. A pediatric ICU, shown located on the seventh floor, has a dedicated patient census station 10a. In addition, an image entry station 20a in the form of a film digitizer station is shown located in an ICU film development area on the seventh floor. There are two ICUs shown located on the eighth floor: a medical ICU (MICU) and a surgical ICU (SICU). The MICU and the SICU share a patient census station 10b at a common nurses station. The ICUs on the eighth floor also use the seventh floor film digitizer station 20a to enter patient information and image data. Note that the image review stations 40a-40d are high-resolution (i.e., 2K) dual-monitor workstations.

FIG. 3B illustrates a high-resolution configuration with wet reading of images in the ICUs. As shown, the radiology department is located on the first floor. Because this hospital has all film developing equipment in radiology, an image entry station 20a is located in radiology near the processors. In this case, a film digitizer station 20a is shown. When film cassettes are brought to radiology

to be developed, the films are feed into the film digitizer station 20a and the appropriate patient and exam information is entered into this system. Also shown located on the first floor is the image server 30 and the imager 50. A pediatric ICU and a surgical ICU (SICU) are shown sharing a nurses station located on the fifth floor. As shown, the pediatric ICU is equipped with a single-monitor image review station 40a and the SICU is equipped with a dual-monitor image review station 40b. A patient census station 10a is shown located at the shared nurses station. An MICU and a cardiac ICU are shown located on the eighth floor sharing a common nurses station. The MICU is equipped with a dual-monitor image review station 40c and the cardiac ICU is equipped with a single-monitor image review station 40d. A patient census station 10b is located at the shared nurses station on the eighth floor. A radiologist dictates wet readings for the ICU exams using any of the image review stations 40 in the ICUs. A clinician in a ICU can listen to the associated report by the radiologist while reviewing the patients images on an image review station 40. Note that the image review stations 40a-d are high-resolution (i.e., 2K) workstations.

FIG. 3C illustrates a medium-resolution configuration with wet reading of images in radiology. As shown, a radiology department is located on the first floor, a cardiac ICU is located on the third floor and a pediatric ICU is located on the sixth floor. The image server 30 is shown located in radiology, as is imager 50. Because this hospital has all film developing equipment in radiology, an image entry station 20a is shown located in radiology near the processors. In this case, a film digitizer 20a is shown. When film cassettes are brought to radiology to

be developed, the films are fed into the film digitizer station 20a and the appropriate patient exam information is entered into the system. A high-resolution (i.e., 2K) image review station 40a is located in radiology, where a radiologist reading from soft copy can dictate wet readings for the ICU exams. On the third floor, a cardiac ICU is shown equipped with a dedicated patient census station 10a and one dual-monitor medium-resolution (i.e., 1K) image review station 40b. On the sixth floor, the pediatric ICU is shown having a dedicated census station 10b and two single-monitor medium-resolution (i.e., 1K) image review stations 40c, 40d. In the ICUs, a clinician while reviewing a patients images on a medium-resolution image review station 40b-40d can listen to the associated report filed by the radiologist.

FIG. 3D illustrates a medium-resolution configuration with hard copy review in radiology. As shown, a radiology department is located on the first floor, a pediatric ICU is located on the seventh floor, a medical ICU (MICU) is located on the eighth floor, and a cardiac ICU and a surgical ICU (SICU) are located on the ninth floor. The image server 30 and the imager 50 are shown located in radiology. In radiology, a radiologist reading the original films can dictate wet readings for the ICU exams into the hospital's existing dictation system. On the seventh floor, a pediatric ICU is shown having one dual-monitor medium-resolution (i.e., 1K) image review station 40a. On the eighth floor, the MICU is shown having one dual-monitor medium-resolution (i.e., 1K) image review station 40b. The patient census station 10a shown located on the eighth floor is shared by the MICU and the pediatric ICU. An image entry station 20a is shown located on the eighth floor. For example, a film digitizer

station can be located in an ICU film development area. The ICUs on the seventh, eighth and ninth floors use that film digitizing station 20a to enter patient information and image data. On the ninth floor, the cardiac ICU is shown having a single-monitor medium-resolution (i.e., 1K) image review station 40c and shares a patient census station 10b with the SICU, which also has a dual-monitor medium-resolution (i.e., 1K) image review station 40d. In the ICUs, a clinician while reviewing a patients images on a medium-resolution image review station 40a-40d can listen to the associated report filed by the radiologist using the existing dictation system.

FIG. 4 is a block diagram of a preferred embodiment of an image server 30 of FIG. 1. The image server 30 uses a dual computer architecture. In particular, a VAX 4000 VLC, or equivalent, is the overall system controller 32 and maintains the demographic and image database 300 and logging and error databases (not shown). Image storage 34 is supplied by an Apple MacIntosh Quadra Model 950, or equivalent. It being understood that various hardware combinations can be used without affecting the scope of the invention.

The VAX 4000 VLC is running the VAX/VMS operating system. The VAX is also equipped with an Ethernet controller and tape cassettes for software distribution and backup.

The Apple Quadra system is equipped with an Ethernet controller 341, with two one-gigabyte magnetic image disk caches 349a, 349b, which is suitable for approximately 400 on-line images. Connected to the Apple system is an operations console 36, which comprises a 12 inch monochrome graphic display, keyboard and mouse. In addition, there can be a

character line printer for printing log and maintenance files. The Apple system also includes an internal modem 342. Finally, there is an image fiber transmission board set 343 comprising of a platform board and a four-port fiber transmitter board, and a laser imager interface board 344.

FIG. 5 is a block diagram of a preferred embodiment of an image review station 40 of FIG. 1. An image review station 40 comprises two major subsystems. One subsystem is a control computer 400. In particular, the control computer is a quadra 950, or equivalent. The second subsystem is a display unit 450, which has either one or two displays 458.

More particularly, the image review station control computer 400 comprises an Apple Macintosh Quadra system with an Ethernet controller and an 80 megabyte magnetic disk 402. Within the computer is an image fiber receiver board 404, a pixel storage board 406, and a display interface board 408. The image fiber receiver board 404 comprises a platform board and a fiber receiver board. The pixel storage board 406 comprises 8 megabytes for a single-monitor display and 16 megabytes for a dual-monitor.

The image review station display unit 450 comprises a first Tektronix Monochrome high-frame rate display 458a, a first display controller 456a for sending video information to the first display 458a, a user interface board 454, a speech I/O board 452 coupled to a speaker 451 and a microphone 453. In a dual-monitor image review station 40, the display unit 450 further comprises a second Tektronix Monochrome high-frame rate display 458b, and a second display controller 456b for sending video information to the second display 458b. Details of the display controller 456 are described in U.S. Patent No. 5,179,639 entitled

"Multiple Buffer Computer Display Controller Apparatus" by James L. Taaffe, the teachings of which are incorporated herein by reference. The user interface board 454 is capable of driving two displays 458a, 458b.

The image review station 40 comprises one or two monitors with input switches running along the bottom and side edges of the monitor. On a single-monitor system, shown in FIG. 6A, the side input switches MS run along the left edge of the screen. On a dual-monitor systems, shown in FIG. 6B, the side input switches MS run along the outside edges of the monitors. In either case there are n side input switches MS. In a preferred embodiment, there are n=16 side input switches MS. In a preferred embodiment, all input switches are touch-sensitive membrane switches. The monitors can be either medium-resolution (i.e., 1K) monitors or high-resolution (i.e., 2K) monitors.

The image review stations 40 are membrane switched driven. The n input switches $MS_1,\ldots,MS_n$ along the side of the monitor are softkeys that allow for selection of items from a menu or list. There are four types of input switches along the bottom of the monitor. The first is a power switch FS_P, which turns the image review station on. There are m input switches on the top row to the right of the power switch FS_P, which are softkeys $SS_1,\ldots SS_m$. Their functions change depending on the state of the application. The bottom row of switches are static fixed-definition switches FS. A start switch FS_S brings the application to a patient listing screen. A help switch FS_H displays help messages that are appropriate to the state of the application. A menu FS_M displays a list of menu functions and an undo switch FS_U undoes the last

command entered. A "yes" switch FS_Y and a "no" switch FS_N allow the user to answer queries posed by the application. Four triangle-shaped or arrow switches AS_U, AS_R, AS_D, AS_L, control the window and center settings for viewing images on the monitor. The arrow switches AS adjust the brightness and contrast on the display 459.

FIG. 7 is a high-level flow chart of the display screens. The image review stations 40 are activated by depressing the power switch FS_P, at step 600. When the image review station 40 is initialized, the patient list is displayed at 610. FIG. 8A is a pictorial representation of a patient list on a single-monitor system. FIG. 8B is a pictorial representation of a patient list on a dual-monitor system. The patient list is a list of all patients in the current ICU. The patient list shows the patients name, the patients medical record number, and the date of the last study. If the last study has not been viewed the date of the last study appears highlighted. The patient list can also be displayed at any time during processing of the application by depressing the start switch FS_S at step 605.

If there are more patients than will fit on the screen, two soft switches at the bottom of the screen are marked forward and back. In a preferred embodiment, the forward function is a assigned to soft switch SS_1 and the back function is the sign to soft switch SS_2. Depressing the forward switch SS_1 causes the list to page forward. Likewise, depressing the back switch SS_2 causes the list to page backward. In an alternative embodiment of the invention, the arrow switches are used to scroll and page through the patient list, such that forward and reverse scrolling

is accomplished by depressing arrow switches AS_D and AS_U, respectively, and forward and backward paging is accomplished by pressing arrow switches AS_R and AS_L, respectively.

During the patient list display, a small window to the right of the patient list is visible and indicates the name of the current ICU and provides user instructions. Alternate ICUs can be selected using the menu switch FS_M at step 665. A patient is selected by depressing the soft switch MS adjacent to the desired patient's name. The selection of a patient is shown at step 620 of FIG. 7.

Once a patient is chosen from the patient list, a study list for that patient is displayed, at step 630. The study list lists all studies for that patient. The study list shows the name of each study, its date and the number of images in the study. FIG. 9A is a pictorial representation of a study list on a single-monitor system. FIG. 9B is a pictorial representation of a study list on a dual-monitor system. A window appearing to the right of the study list shows demographic information about the patient and provides user instructions.

The user selects the study from the study list at step 640. To choose a study from the study list, the user presses a soft switch MS adjacent to the desired study. If there are more studies for the patient that will fit on the screen, the user can scroll or page through the list of studies. The paging and scrolling is accomplished as described above in the description of the patient list.

After a study is chosen, images from the study are display at step 650. In a preferred embodiment of the invention, the first image in the selected study is

displayed. If a dual-monitor system is used, the first image is displayed on the left monitor and the second image in the study, if there are a plurality of images in the study, is displayed on the right monitor. FIG. 10A is a pictorial representation of a display image 455a on a single-monitor system. FIG. 10B is a pictorial representation of a display image 455a,455b on a dual-monitor system. The name of the patient, the patient medical record number, the name of the study, and the date of the study appear on the top of the display screens.

A list of images in this study appears next to the switches MS on the side of the monitor. The list item representing the current image displayed on the monitor appears highlighted. As shown, there are two images in the study; a posteroanterior (PA) image is displayed on the left monitor 458a and a lateral (LAT) image is displayed on the right monitor 458b. To view a different image, the user selects the switch MS adjacent to the name of the desired image. If the image displayed on the left monitor 458a is changed, the display on the right monitor 458b is updated to show the next sequential image in the study.

While viewing the images, the user can return to the study list by depressing the soft switch associated with "exam list" SS_3 at step 625. FIG. 11 is a pictorial representation of the study list on the right monitor of a dual-monitor system. Using the study list, the user can choose to look at a different study.

While the user is viewing images 455, the user can listen to voice annotations, read text annotations, and control the brightness and contrast of the display. If a dual-monitor system is used, the user can also compare images from different studies.

As a user views an image 455, the user can adjust the brightness and contrast of the display image to accentuate different tissue densities. Three soft switches SS_4, SS_5, SS_6 and the arrow switches AS on the bottom of the monitor allow the user to adjust the brightness and contrast. The easiest way for a user to control the brightness and contrast is to use built-in presets. When an image is displayed on one of the monitors, three soft switches will be labeled as preset switches. These preset switches can be labeled to represent standard tissue densities (e.g., bone, soft tissue, etc.). Alternatively, one preset switch SS_4 displays a full range brightness and contrast, a second preset switch SS_5 displays a narrow dark mode, and a third preset switch SS_6 displays a narrow light mode.

To allow display flexibility, the arrow switches AS can be used to control contrast and brightness. In general, the up arrow AS_U and the down arrow AS_D control brightness, and the left AS_L and the right arrow AS_R control contrast.

When an image is digitized, a preferred embodiment of the system records 4096 shades of gray from completely black (i.e., 0) to completely white (i.e., 4095). The preferred monitors can only display 256 shades of gray, so the system maps shades stored in the image to one of the 256 it can display on the screen. In other words, images are digitized as 12-bit gray-scale images and displayed as 8-bit gray-scale images. To control brightness and darkness, the user controls how the system maps image gray shades to display gray shades.

When initially displayed, the 4096 image shades are spread out evenly over the 256 display shades. This spread is called the window. To increase

contrast, the user narrows the window so fewer image shades map to the display shades. As one example, image shades 1293 to 3872 can map to the 256 display shades. Any gray darker than 1293 is displayed as black, and any shade lighter than 3872 is displayed as white. In another example, the 256 display shades are determined by the most-significant 8 bits of the 12-bit intensity digitized images, the least-significant bits being truncated.

The midpoint between the lightest image shade and the darkest image shade in the window is called the center. The center determines which image shades correspond to a 50% gray on the display. Initially, image shade 2048 corresponds to display shade 128. Both values represent 50% grays. To increase the brightness, the user maps the center to lighter image shades. To make the image darker, the user maps the center to darker image shades.

The up arrow AS_U and the down AS_D control the center, and the right arrow AS_R and the left arrow AS_L control the width of the window. The up arrow AS_U maps the center to lighter image shades (i.e., brighter). The down AS_D match the center to darker image shades (i.e., darker). The right arrow AS_R makes the window wider (i.e., less contrast). The left arrow AS_L makes the window narrower (i.e., more contrast).

Every study can have associated voice annotations and text annotations. While the user is viewing an image 455, the user can view text annotations and listen to and record voice annotations at the image review station. Text annotations are usually recorded at the patient census station 10.

To view a text annotation the user depresses the soft switch labeled "text note" SS_1. A window that

contains a text note appears on the screen. The window containing the text annotation can be removed from view by again depressing the soft switch labeled "text note" SS_1.

To listen to a voice annotation, the user depresses the soft switch labeled "voice note" SS_2. The voice annotation associated with the current study plays through the image review station's 40 built-in speaker 451. While a voice annotation is playing, the user can use the arrow switches AS to control the playback. Volume is controlled by the up arrow AS_U to increase volume and the down arrow AS_D to decrease volume. The right arrow AS_R fast-forwards the playback and the left arrow AR_L rewinds the playback. The voice annotation is stopped by again depressing the "voice note" switch SS_2.

To record a voice annotation the user presses the menu switch FS_M. The image will be replaced with a list of several choices as shown in FIG. 13, which will be discussed in detail below.

On a dual-monitor image review station 40, the right monitor 458b usually displays the next sequential images in this study. However, the user can use that monitor to display image from a different study. Thus, images from two different studies can be compared. For example, the user can compare images from one day with images from another day to track the patient's recovery.

Returning to FIG. 10b, while the user is viewing an image 455, the user can depress the soft switch labeled "comparison study" SS_1 on the right monitor 358b. A comparison study list for the current patient appears on the right monitor 458b as shown in FIG. 11. A study is selected using the corresponding switch MS

adjacent to the desired study. In a preferred embodiment of the invention, the current study displayed on the left monitor 458a is excluded from the comparison study list.

After a comparison study is selected, the first image in that study is displayed on the right monitor 458b. This display is similar to the display on the left monitor 458a, but in addition to the patient's name, patient medical record number, study name, and study date, the word "COMPARISON" appears on the top of the screen. Thus, the user is aware that two different studies are being examined. All images in the comparison study appear in the list on this screen, with the current comparison image being highlighted. To display one of these images the soft switch MS adjacent to the image name is depressed. FIG. 12 is a pictorial representation of a comparison study.

At any time, the user can press the menu switch FS_M. In FIG. 7, the accessing of the menu is shown in step 660. FIG. 13 is a pictorial representation of the menu screen. By selecting corresponding switches MS, the user can print the current image to film, print all images in the current exam to film, print all images for the current patient to film, record a voice note, choose another intensive care unit, perform a self test, perform quality control, configure the system, restart the system, or shut down the system. Each function will be discussed in turn.

The user can print the current image, all the images for the current study, and all images for the current patient from the image review station 40 using respective switches MS_1,MS_2,MS_3. The print request goes to the imager 50, where the images will be printed on film. The image review station queries the user for

an ID number. The user enters an ID number using the switches MS on the screen. After the ID number is entered, the image review station 40 displays a message asking the user to confirm the print request. The user responds using either the "yes" switch FS_Y or the "no" switch FS_N.

Usually, a user will be viewing studies for patients in a particular ICU. The user can choose the ICU from which to select patient studies. To choose an ICU other than the current ICU the user depresses a corresponding menu switch MS_5. The list of commands changes to a list of intensive care units. The user selects the ICU using the menu switches MS. The display then shows the patient list for the chosen ICU.

By selecting a menu switch adjacent to the "record voice note" selection the user can record a voice annotation. After pressing the corresponding menu switch MS_4, the image review station 40 queries the user for an ID number. The user enters the ID number using the switches on the edge of the screen. If a voice note already exists for this study, the image review station 40 queries the user to ask if the existing note is to be replaced. The user responds either "Yes" switch FS_Y or the "No" switch FS_N.

The user can use the configure switch MS_9 to configure various system settings. Using the configure option, the user can redefine bottom-row softkey $SS_1,\ldots,SS_m$ settings. For example, the user can configure the window and center parameters for the preset switches $SS_4,\ldots,SS_6$. The user can also use the configure switch MS_9 to select a zoom option for low-resolution monitors, so that a section of the image is magnified to display the images in more detail. If the zoom option is selected, a preset softkey (e.g. SS_6)

function is replaced by a zoom function. By depressing the zoom softkey SS_6, a quadrant menu is displayed. The user selects the quadrant to be magnified using the adjacent menu switch MS. In a preferred embodiment of the invention, there are 5 display quadrants (i.e. top left, top right, center, bottom left, and bottom right) that can be magnified.

Depressing the restart switch MS_{10} returns the user to the patient list display (step 610). Thus, the restart switch MS_{10} is equivalent to a power switch FS_p.

The user turns the image review station off using the menu of FIG. 13. By depressing the shut down switch MS_{11}, the system automatically performs a shut down procedure (step 670).

Equivalents

While the invention has been particular shown and described with reference to a preferred embodiment thereof, it will understood by those skilled in the art that various changes in form and details may be made therein without departing from spirit and scope of the invention as defined by the appended claims.

CLAIMS

1. A monitor coupled to a radiographic image data processing unit, comprising:

a display screen coupled to a video source for displaying radiographic images to a user;

a monitor housing for mounting the display screen; and

a plurality of touch-sensitive input switches coupled to the data processing unit and disposed on the monitor housing adjacent to the display screen for accepting user inputs.

2. The monitor of Claim 1 wherein the input switches comprise a first and a second plurality of softkeys defined based on the state of the display.

3. The monitor of Claim 2 wherein the first plurality of softkeys are registered to a display list for selecting an item from the display list.

4. The monitor of Claim 2 wherein the second plurality of softkeys are registered to a display function for controlling the state of the display.

5. The monitor of Claim 1 wherein the input switches comprise a plurality of hardkeys having fixed definitions.

6. The monitor of Claim 1 wherein the display screen is a Cathode Ray Tube (CRT) display screen.

7. An apparatus for displaying radiographic images stored in an image database, comprising:

an image review station coupled to the image database, the image review station retrieving stored images from the image database and converting retrieved images into display images for display to a user; and

at least one monitor having touch-sensitive input switches adjacent to the perimeter of a respective display screen and coupled to the image review station for displaying a respective display image.

8. The apparatus of Claim 7 wherein the input switches of a first monitor represent a first set of user commands, the user selecting a first stored image to be displayed using the input switches of the first monitor, the first monitor signaling the image review station in response to the input switches of the first monitor.

9. The apparatus of Claim 8 wherein the input switches of a second monitor represent a second set of user commands, the user selecting a second stored image to be displayed simultaneously with the first display image using the input switches of the first monitor and the second monitor, the second monitor signaling the image review station in response to the input switches of the second monitor.

10. The apparatus of Claim 9 wherein the first monitor displays images from a first study and the second monitor displays images from a second study, such that the images of the first and the second study can be compared.

11. The apparatus of Claim 9 wherein the image review station correlates the second display image with the first display image, such that image adjustments made to the first display image by the user are made to the second display image by the image review station.

12. The apparatus of Claim 11 wherein the image adjustments comprise brightness and contrast adjustments made using the input switches.

13. The apparatus of Claim 11 wherein the image adjustments comprise zooming the image using the input switches.

14. A system for archiving and reviewing radiographic data for a plurality of patients, each patient having at least one radiography study and each radiographic study having at least one radiographic image, comprising:

an image database for storing radiographic data, the radiographic data including digital representations of radiographic images, text data, and voice annotation data, the radiographic data being stored in an organized structure by radiographic study per patient; and

an image review station coupled to the image database for accessing radiographic images and text data from the image database and for entering voice annotation data in the image database, the radiographic images and text data being displayed to a user and the voice annotation data being played to the user in response to a set of commands.

15. The system of Claim 14 wherein the coupling comprises optical links.

16. The system of Claim 15 wherein the system is an optical image Local Area Network.

17. The system of Claim 14 further comprising a film digitizer station for electronically digitizing conventional radiographs and entering the digitized radiographs into the image database.

18. The system of Claim 14 further comprising a computed radiography station for entering computed radiographs into the image database.

19. The system of Claim 14 wherein the image review station comprises a first monitor having input switches, the input switches of the first monitor representing a first set of user commands, the user selecting a first stored image to be displayed on the first monitor using the input switches of the first monitor, and the first monitor displaying a first display image in response to the selected input switches of the first monitor.

20. The system of Claim 19 wherein the image review station further comprises a second monitor having input switches, the input switches of the second monitor representing a second set of user commands, the second monitor displaying a second display in response to the selected input switches of the first monitor and the second monitor, the second display images being displayed simultaneously with the first display image.

21. The system of Claim 20 wherein the second monitor displays the next sequential image in the radiographic study after the image displayed on the first monitor.

22. The system of Claim 20 wherein the second monitor displays images from a different radiographic study than the image displayed on the first monitor.

23. The system of Claim 14 wherein the image review station is located remote from the image entry station.

24. The system of Claim 14 wherein there are a plurality of image review stations, each image review station providing simultaneous access to stored radiographic data.

25. The system of Claim 14 wherein the image database is a server in a client-server system.

26. The system of Claim 25 wherein the image database is accessed by an image server.

27. A method for controlling a display on a monitor coupled to a radiographic image data processing unit, comprising the step of:

coupling a display screen secured within a monitor housing to a video source for displaying radiographic images to a user; and

accepting user inputs, using a plurality of touch-sensitive input switches disposed on the monitor housing adjacent to the perimeter of the display screen, the input switches being coupled to the data processing unit.

28. A method for displaying radiographic images stored in an image database, comprising the steps of:

selecting a stored image to be displayed using touch-sensitive input switches adjacent to the perimeter of a display screen of a monitor; and

retrieving stored images from the image database and converting retrieved images into display images for display to a user in response to the input switch selections.

29. The method of Claim 28 further comprising the step of representing a first set of user commands using the input switches of a first monitor.

30. The method of Claim 29 further comprising the step of representing a second set of user commands using the input switches of a second monitor.

31. The method of Claim 29 further comprising correlating a second display image with a first display image, such that image adjustments made to the first display image by the user are made to the second display image by the image review station.

32. The method of Claim 31 wherein the step of correlating comprises adjusting brightness and contrast.

33. The method of Claim 31 wherein the step of correlating comprises zooming the image.

34. A method for archiving and reviewing radiographic data for a plurality of patients, each patient having at least one radiography study and each radiographic study having at least one radiographic image, comprising the steps of:

storing radiographic data in an image database, the radiographic data including digital representations of radiographic images, text data, and voice annotation data, the radiographic data being stored in an organized structure by radiographic study per patient; and

accessing radiographic images and text data from the image database, the radiographic images and text data being displayed to a user and the voice annotation data being played to the user in response to a set of commands.

35. The method of Claim 34 wherein the step of storing comprises electronically digitizing conventional radiographs and entering the digitized radiographs into the image server.

36. The method of Claim 34 wherein the step of storing comprises entering computed radiographs into the image.

37. The method of Claim 34 wherein the step of accessing comprises selecting a first stored image to be displayed on a first monitor using input switches of the first monitor, the input switches of the first monitor representing a first set of user commands, and the first monitor displaying a first display image in response to the selected input switches of the first monitor.

38. The method of Claim 37 wherein the step of accessing further comprises displaying a second display image on a second monitor in response to selecting input switches of the first monitor and the second monitor, the input switches of the second monitor representing a second set of user commands, the second display images being displayed simultaneously with the first display image.

39. The method of Claim 38 wherein the step of displaying the second display image comprises displaying the next sequential image in the study after the image displayed on the first monitor.

40. The method of Claim 38 wherein the step of displaying the second display image comprises displaying images from a different study than the first display image.

41. The method of Claim 38 wherein the step of accessing comprises providing simultaneous access to stored radiographic data.

42. A method of operating an image review station coupled to at least one monitor having a display screen, in a radiographic picture archiving and communication system, comprising the steps of:

on a first monitor, providing a plurality of touch-sensitive input switches adjacent to the perimeter of the display screen for entering user commands to the image review station;

selecting a patient from a displayed list of patients using the input switches;

selecting a study from a displayed list of studies using the input switches; and

displaying an image from the selected study on a first monitor.

43. The method of Claim 42 further comprising, before selecting a patient, the step of selecting a care unit.

44. The method of Claim 42 wherein the step of selecting a care unit comprises the step of selecting a care unit from a displayed list of care units using the input switches.

45. The method of Claim 42 wherein the step of displaying an image comprises displaying the first sequential image in the selected study.

46. The method of Claim 42 further comprising the steps of:

displaying a list of images in the selected study on the first monitor simultaneously with the displayed image.

selecting an image from the displayed list of images using the input switches; and

displaying the selected image on the first monitor.

47. The method of Claim 46 further comprising the step of displaying the next sequential image in the selected study on a second monitor.

48. The method of Claim 42 further comprising the step of correlating adjustments to the image displayed on the first monitor made using the input switches of the first monitor with an image displayed on a second monitor.

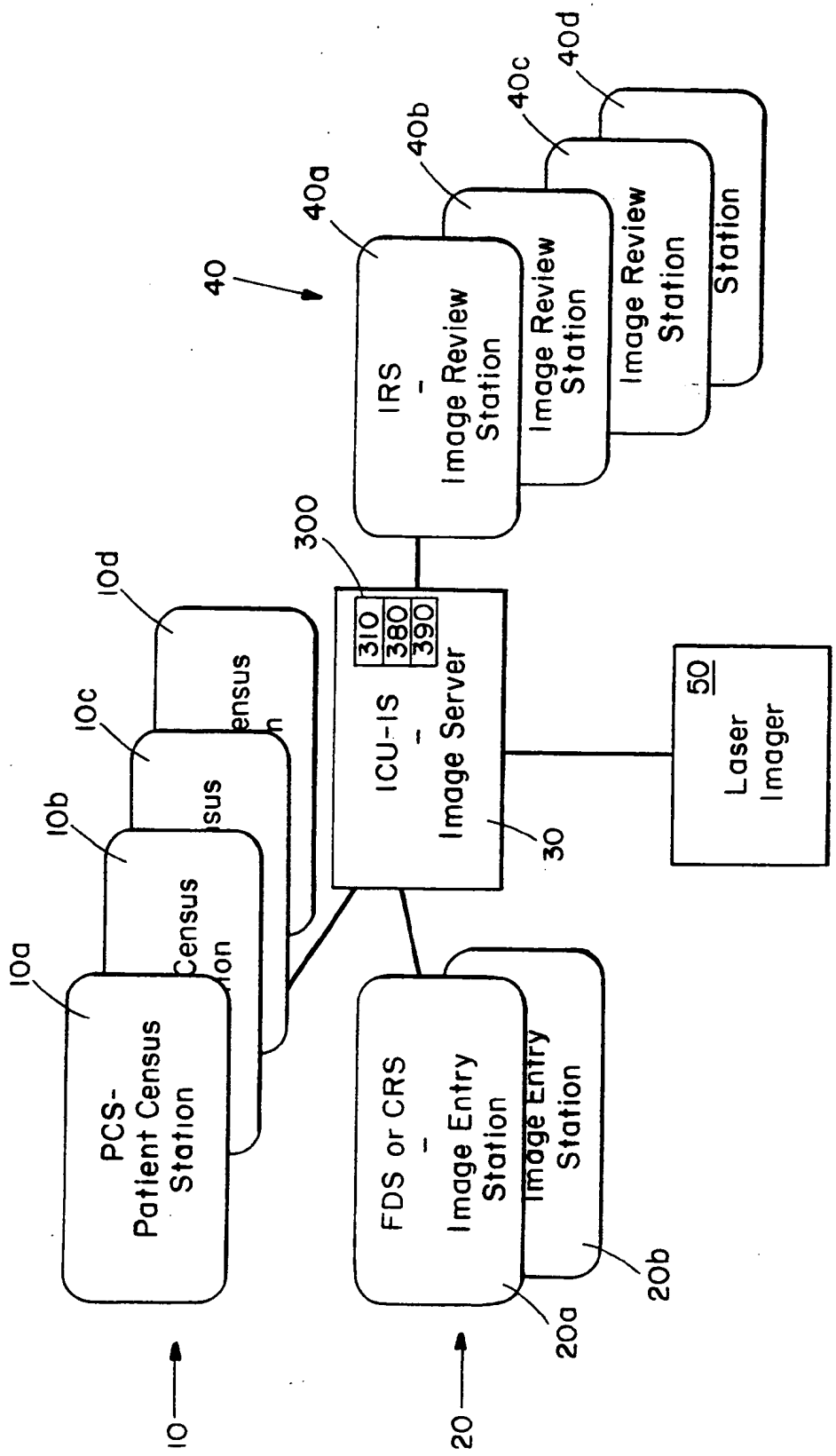

FIG. 1

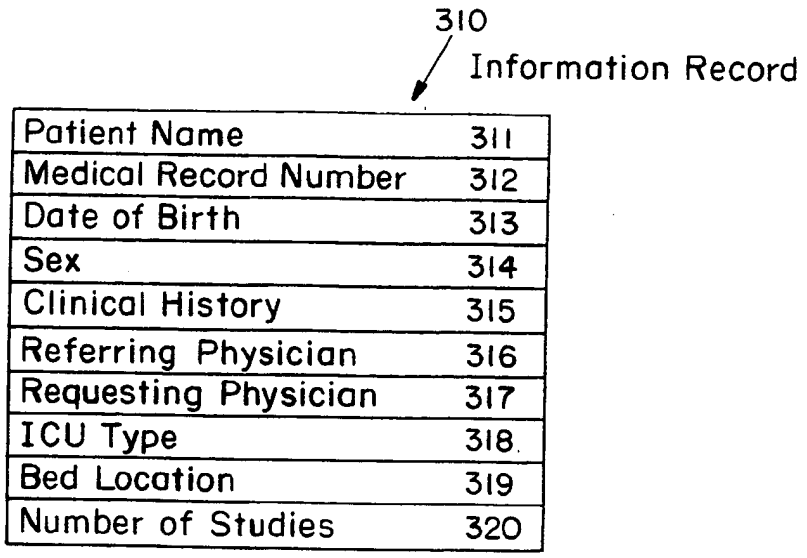
310
Information Record
Patient Name 311
Medical Record Number 312
Date of Birth 313
Sex 314
Clinical History 315
Referring Physician 316
Requesting Physician 317
ICU Type 318
Bed Location 319
Number of Studies 320

FIG. 2A

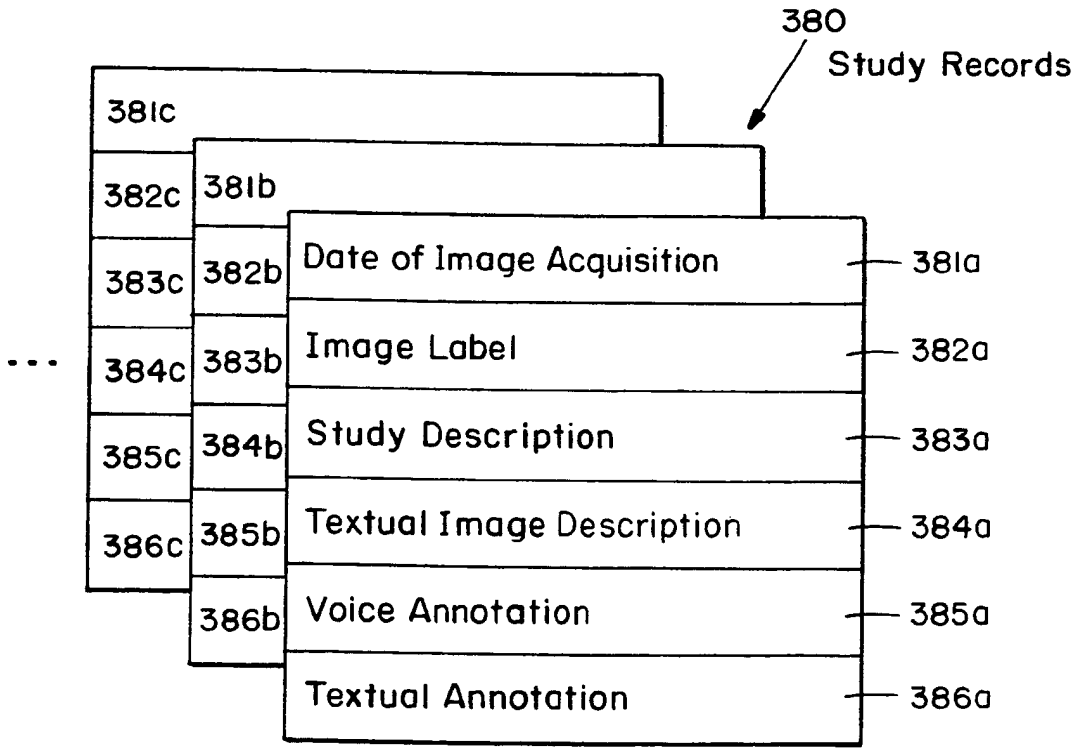
380
Study Records
381c
382c
381b
383c
382b
Date of Image Acquisition
381a
384c
383b
Image Label
382a
385c
384b
Study Description
383a
386c
385b
Textual Image Description
384a
386b
Voice Annotation
385a
Textual Annotation
386a

FIG. 2B

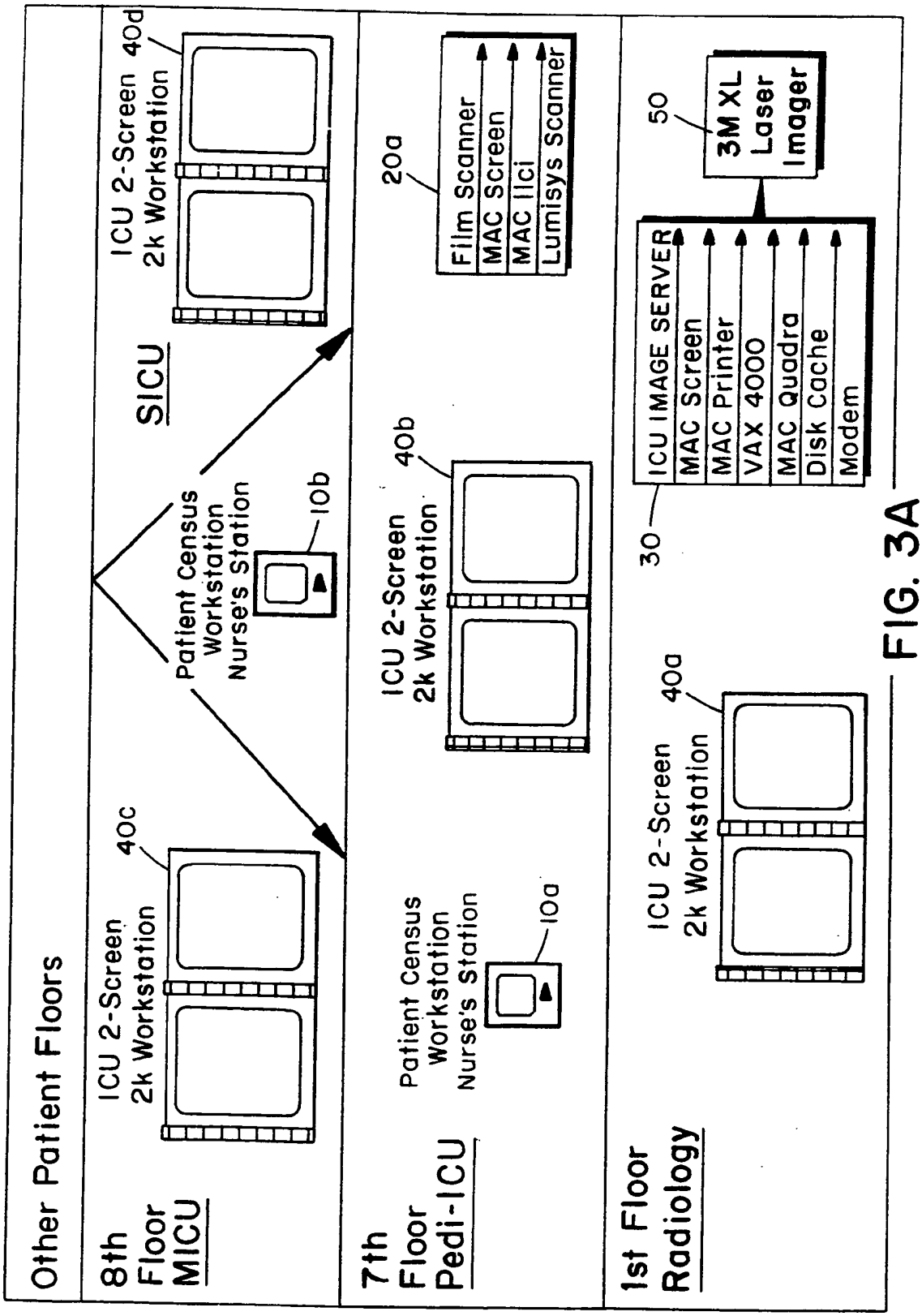
Other Patient Floors
8th Floor MICU
ICU 2-Screen 2k Workstation
40c
7th Floor Pedi-ICU
Patient Census Workstation Nurse's Station
10a
ICU 2-Screen 2k Workstation
40b
SICU
ICU 2-Screen 2k Workstation
40d
Patient Census Workstation Nurse's Station
10b
20a
Film Scanner
MAC Screen
MAC IIci
Lumisys Scanner
1st Floor Radiology
ICU 2-Screen 2k Workstation
40a
30
ICU IMAGE SERVER
MAC Screen
MAC Printer
VAX 4000
MAC Quadra
Disk Cache
Modem
50
3M XL Laser Imager

FIG. 3A

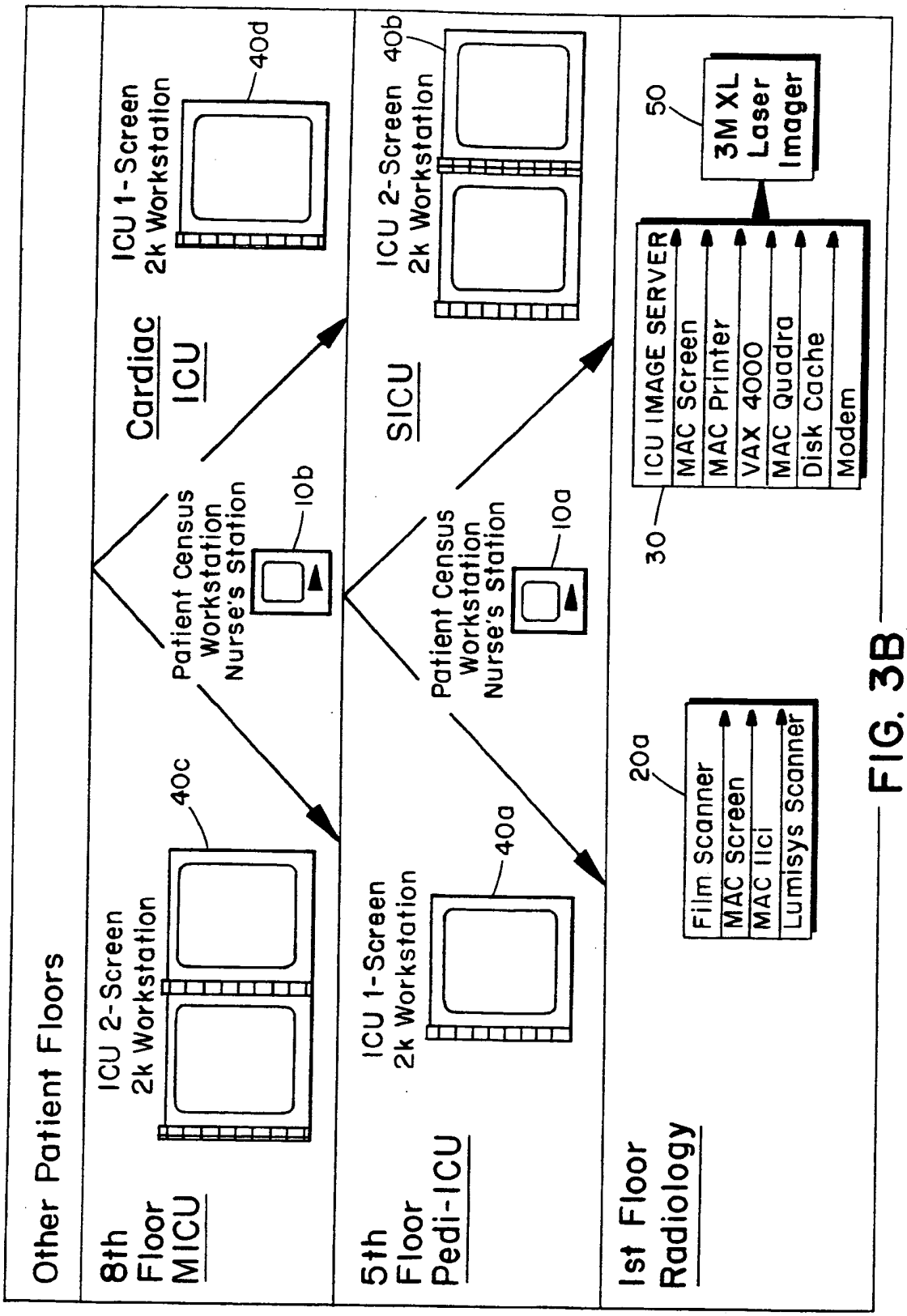

FIG. 3B

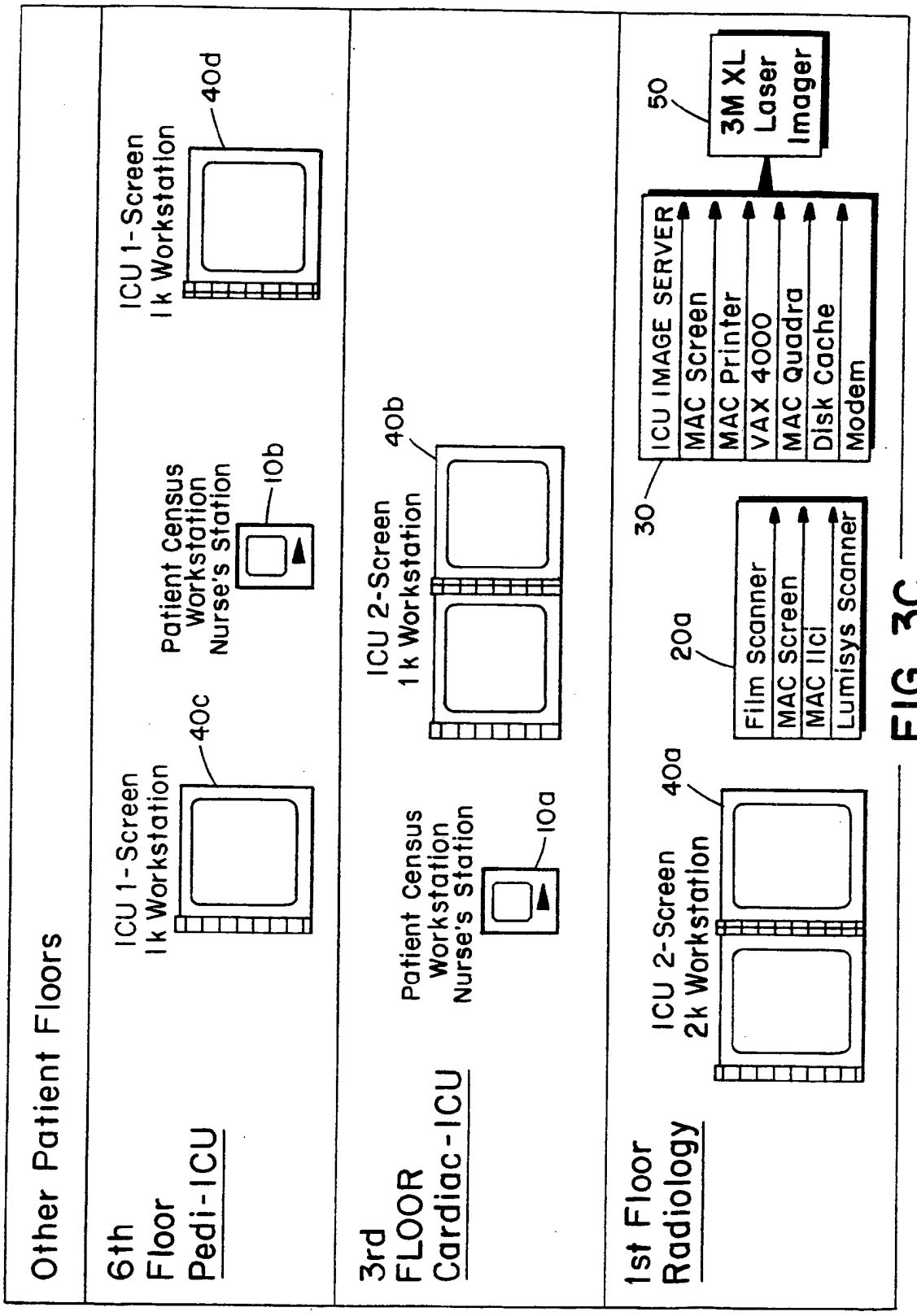

FIG. 3C

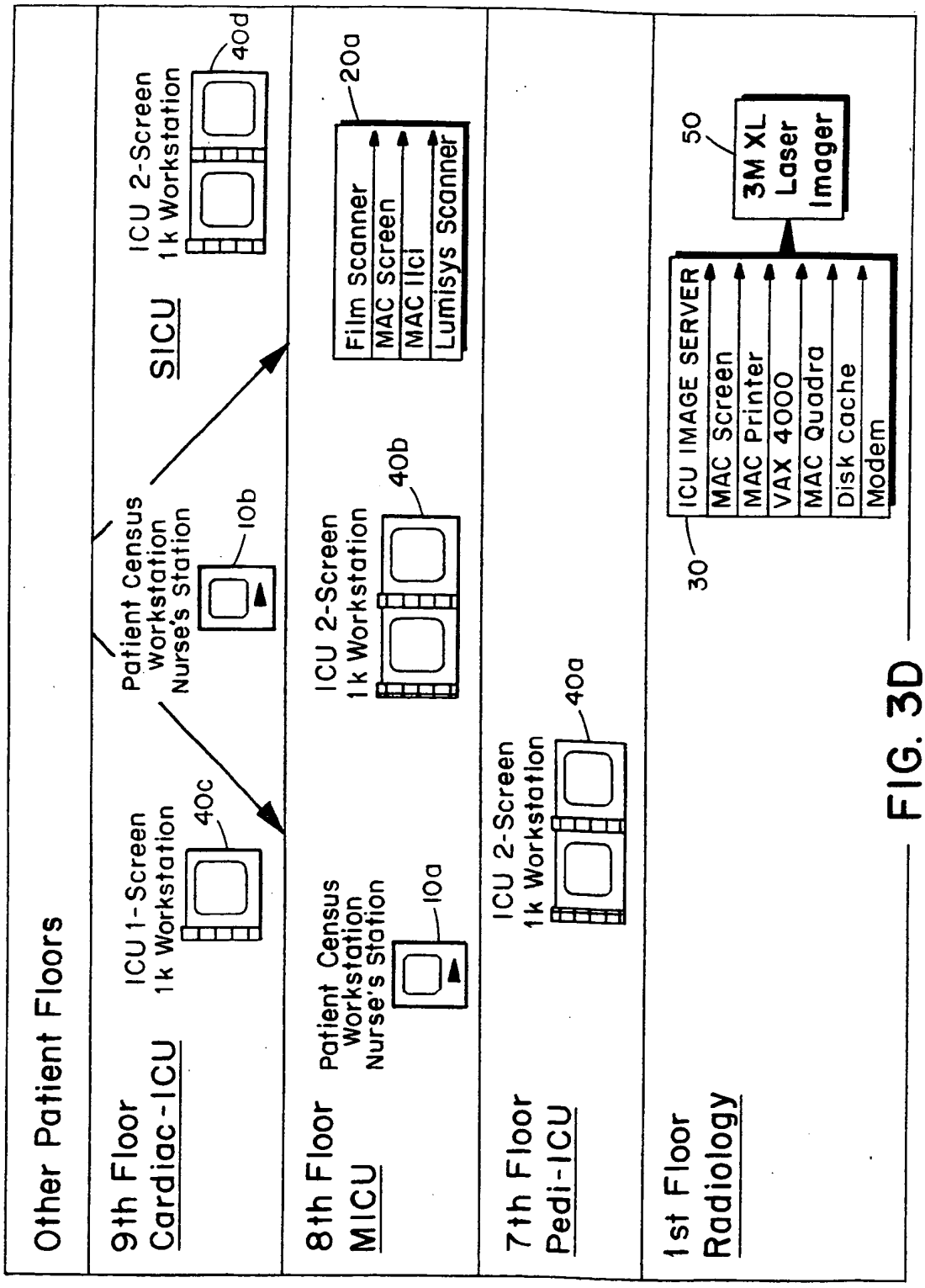

FIG. 3D

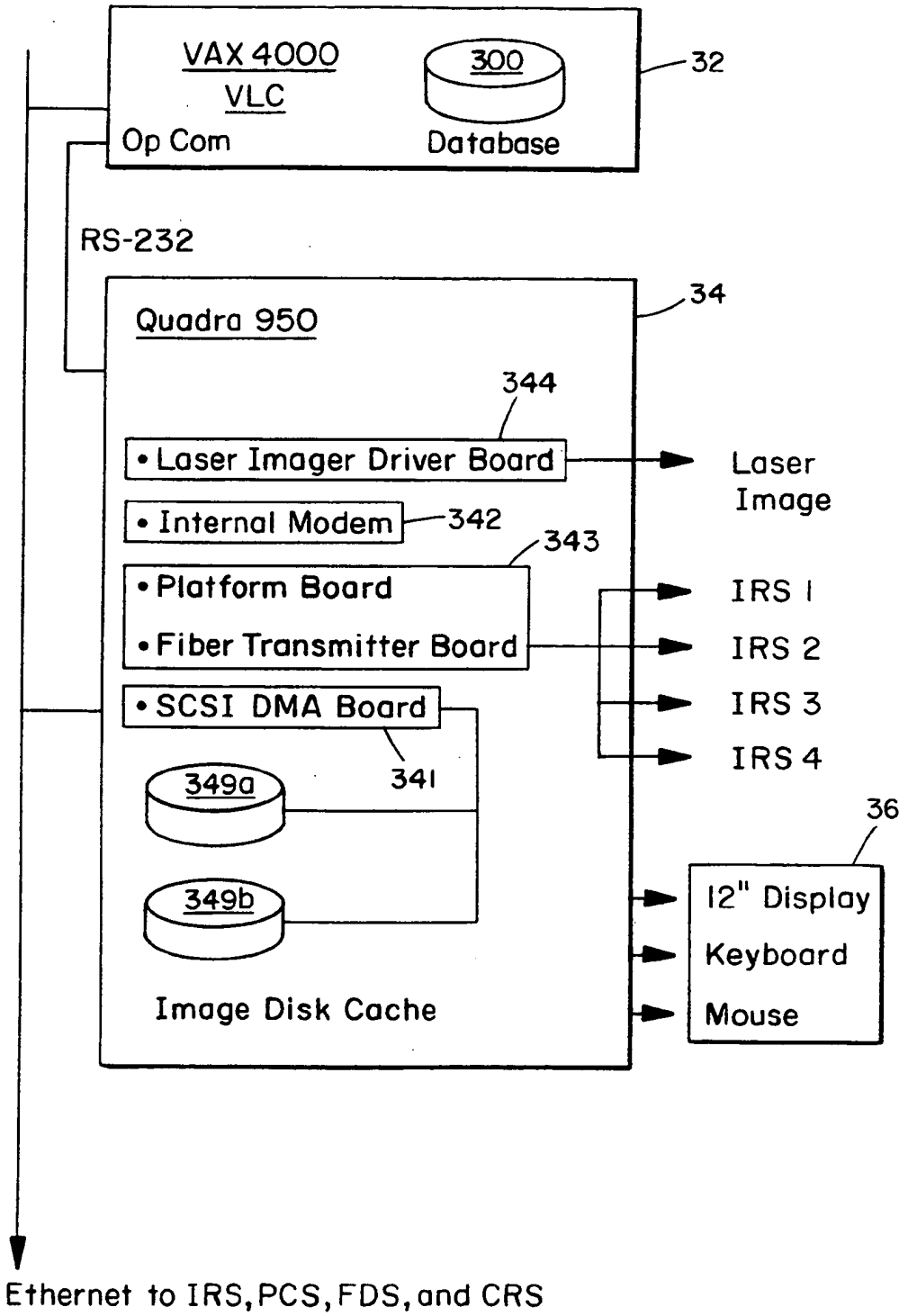

FIG. 4

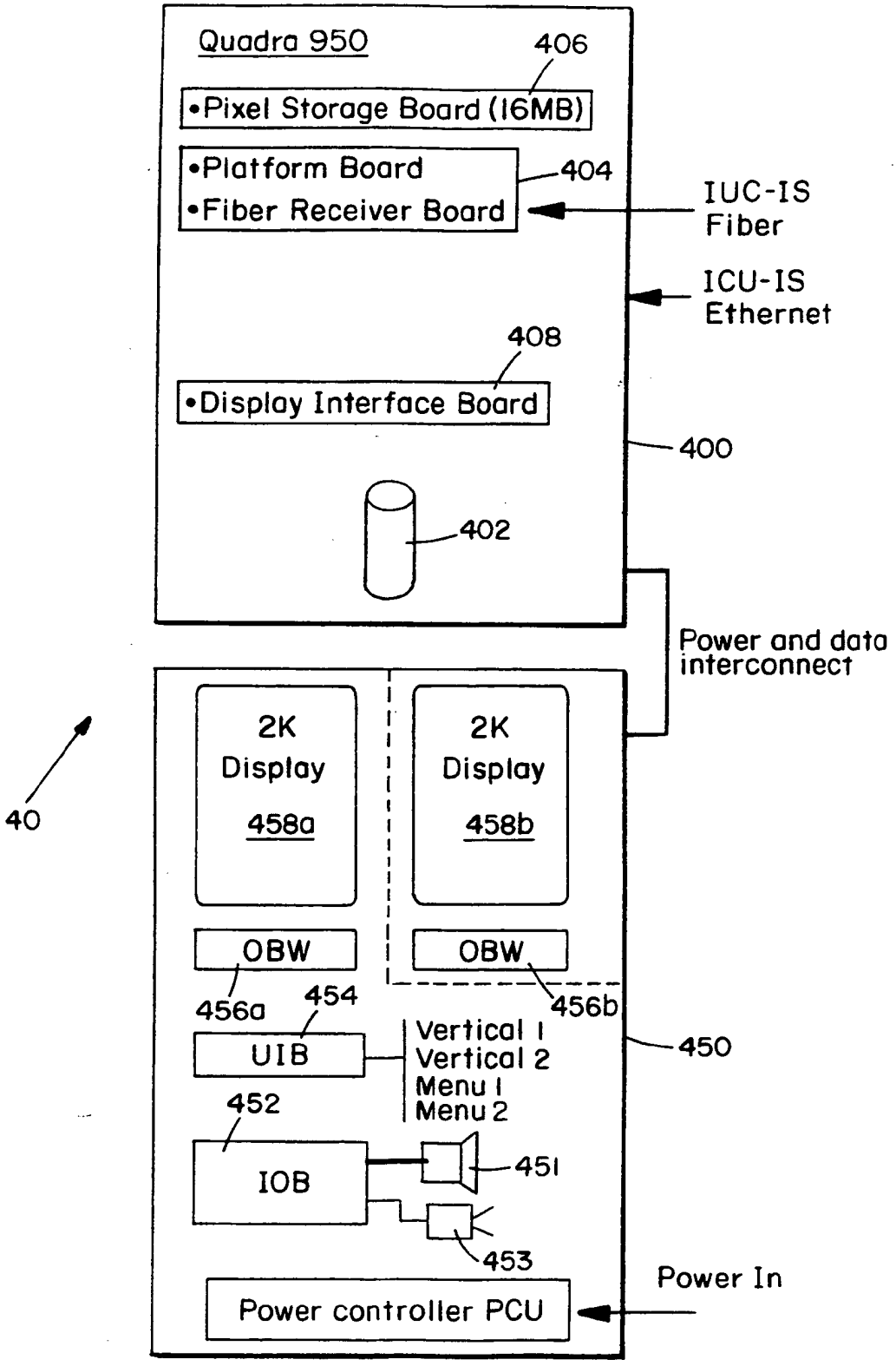
Quadra 950
406
•Pixel Storage Board (16MB)
•Platform Board
•Fiber Receiver Board
404
IUC-IS Fiber
ICU-IS Ethernet
408
•Display Interface Board
400
402
Power and data interconnect
40
2K Display 458a
2K Display 458b
OBW
OBW
456a
454
456b
UIB
Vertical 1
Vertical 2
Menu 1
Menu 2
450
452
IOB
451
453
Power In
Power controller PCU

FIG. 5

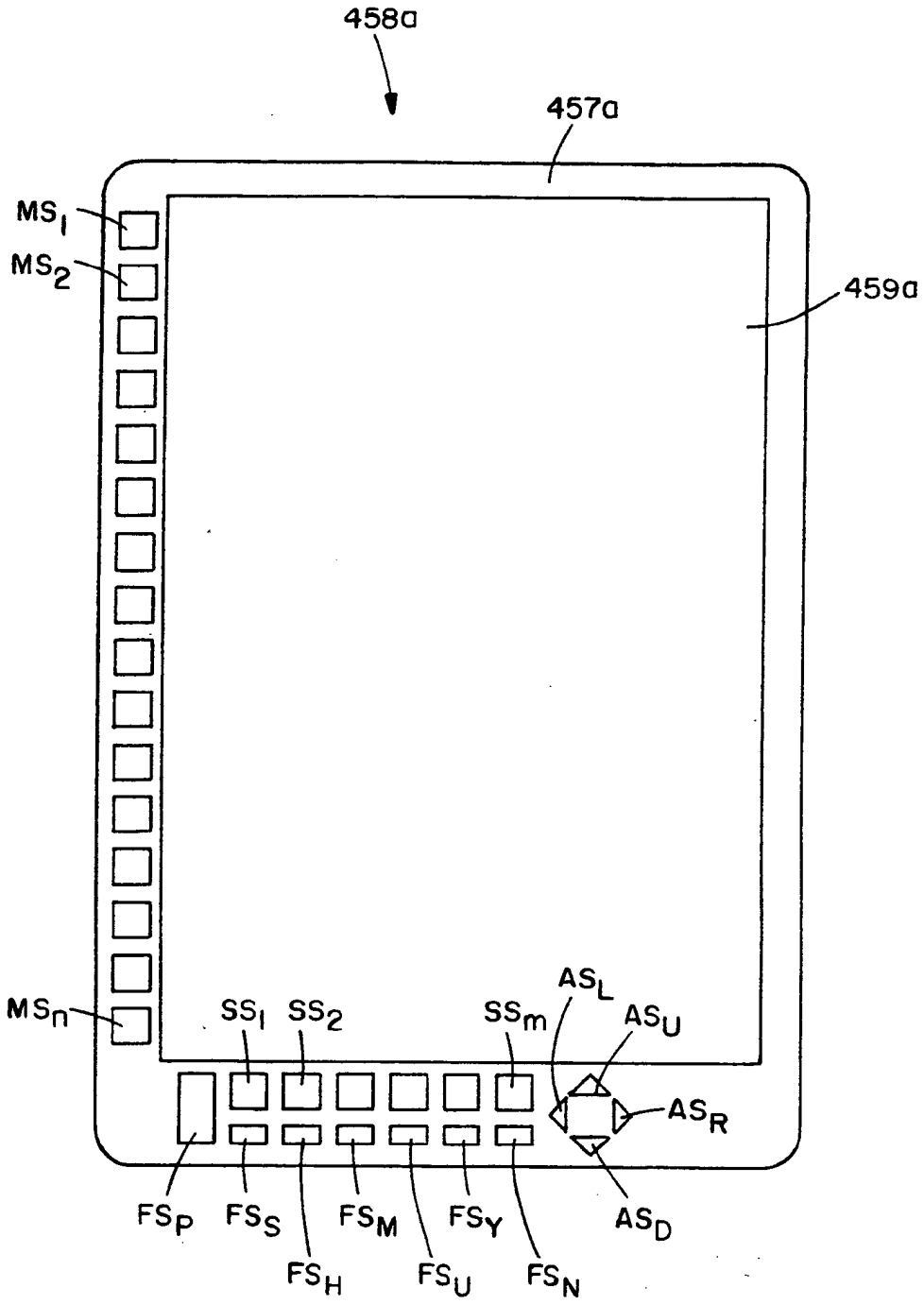
458a
457a
459a
MS1
MS2
MSn
SS1
SS2
SSm
ASL
ASU
ASR
ASD
FSP
FSS
FSH
FSM
FSU
FSY
FSN

FIG. 6A

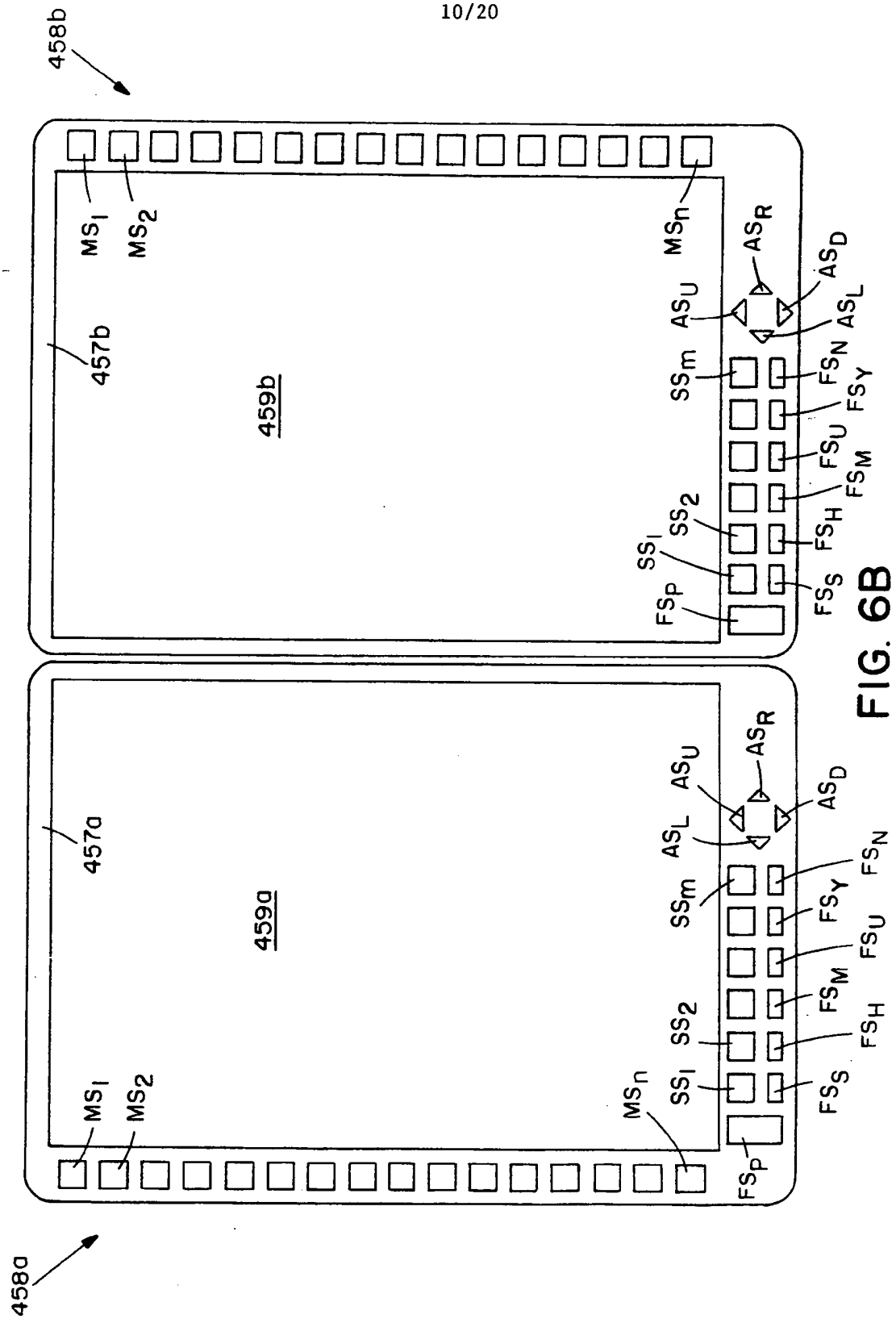
458b
MS1
MS2
MSn
457b
459b
ASR
ASD
ASU
ASL
SSm
SS2
SS1
FSP
FSN
FSY
FSU
FSM
FSH
FSS
457a
459a
458a

FIG. 6B

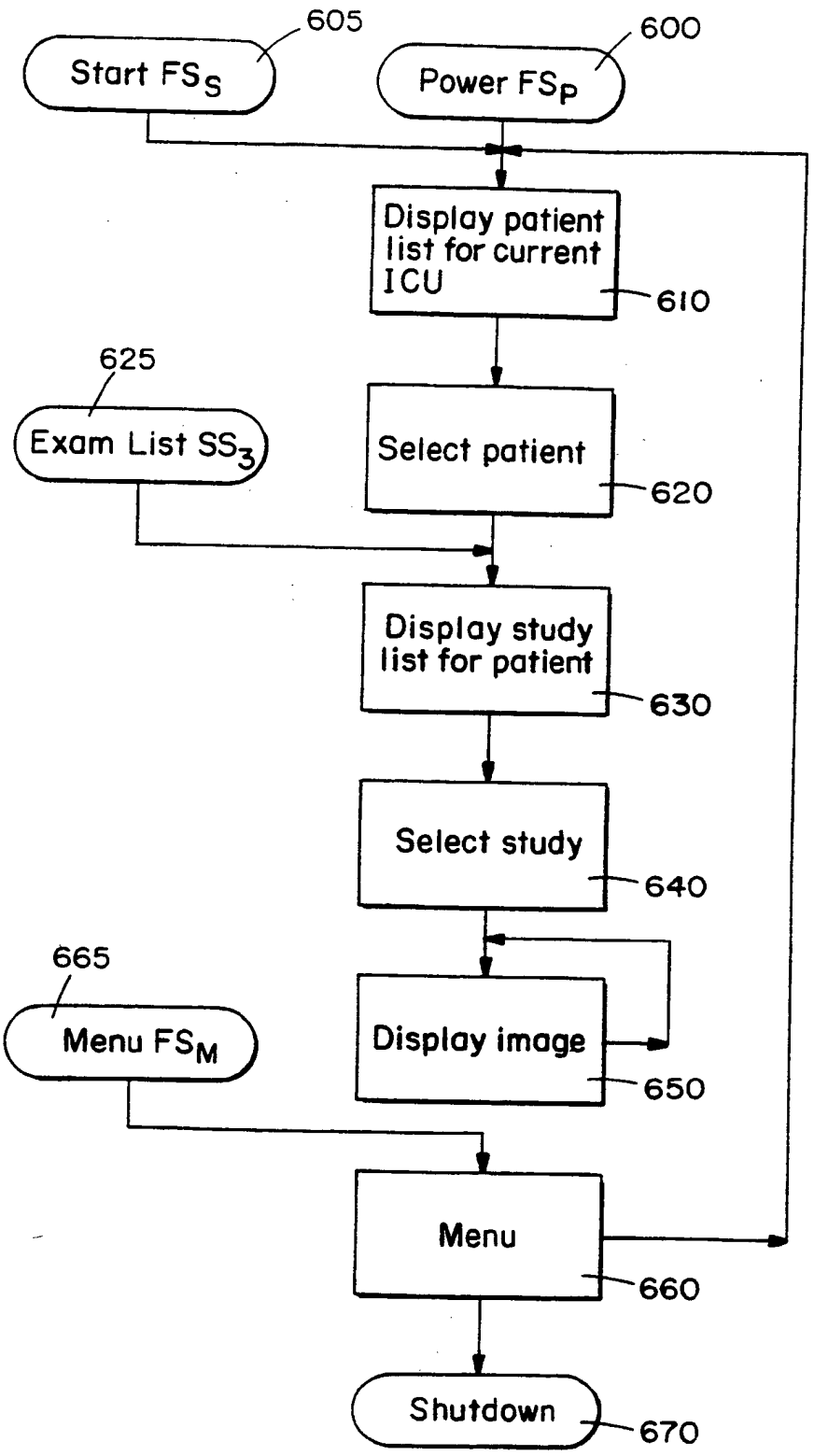

FIG. 7

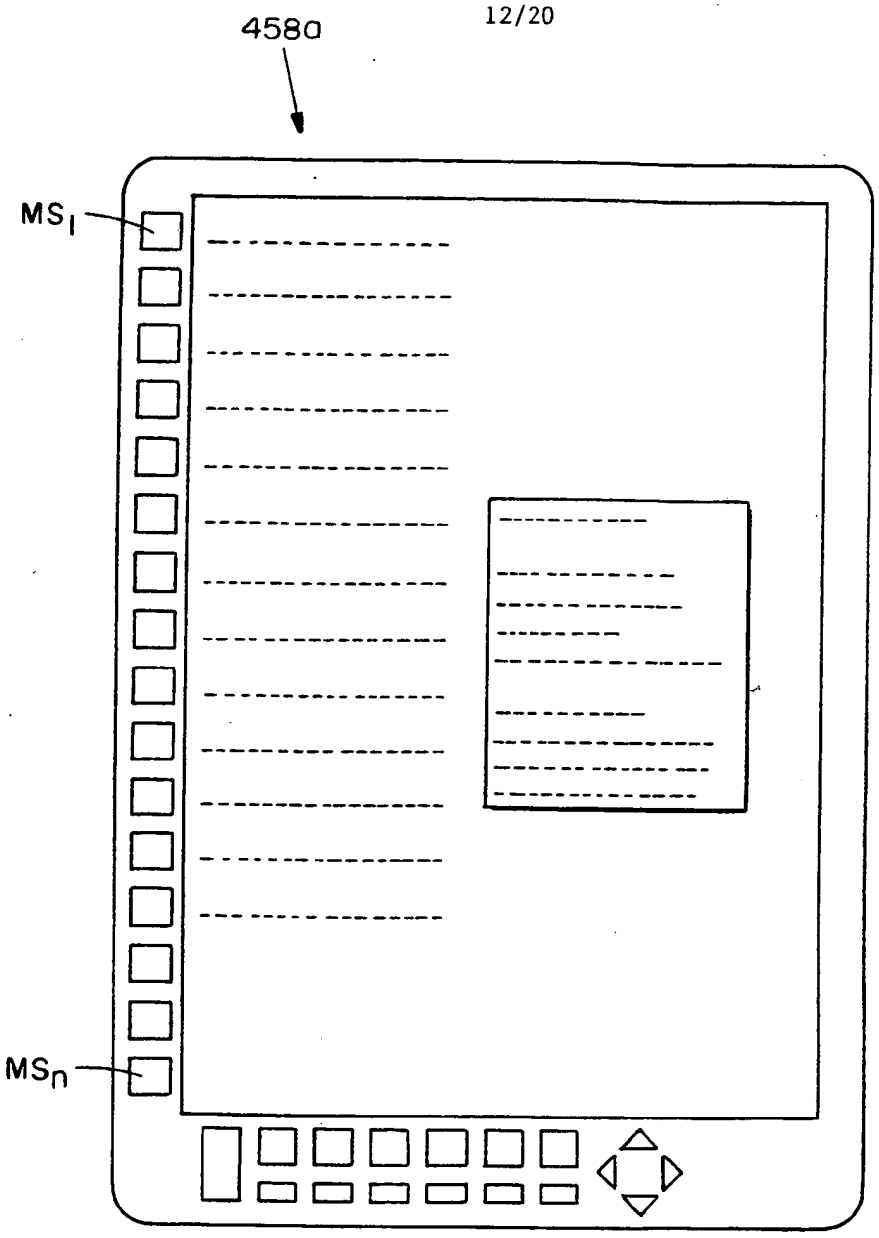

FIG. 8A

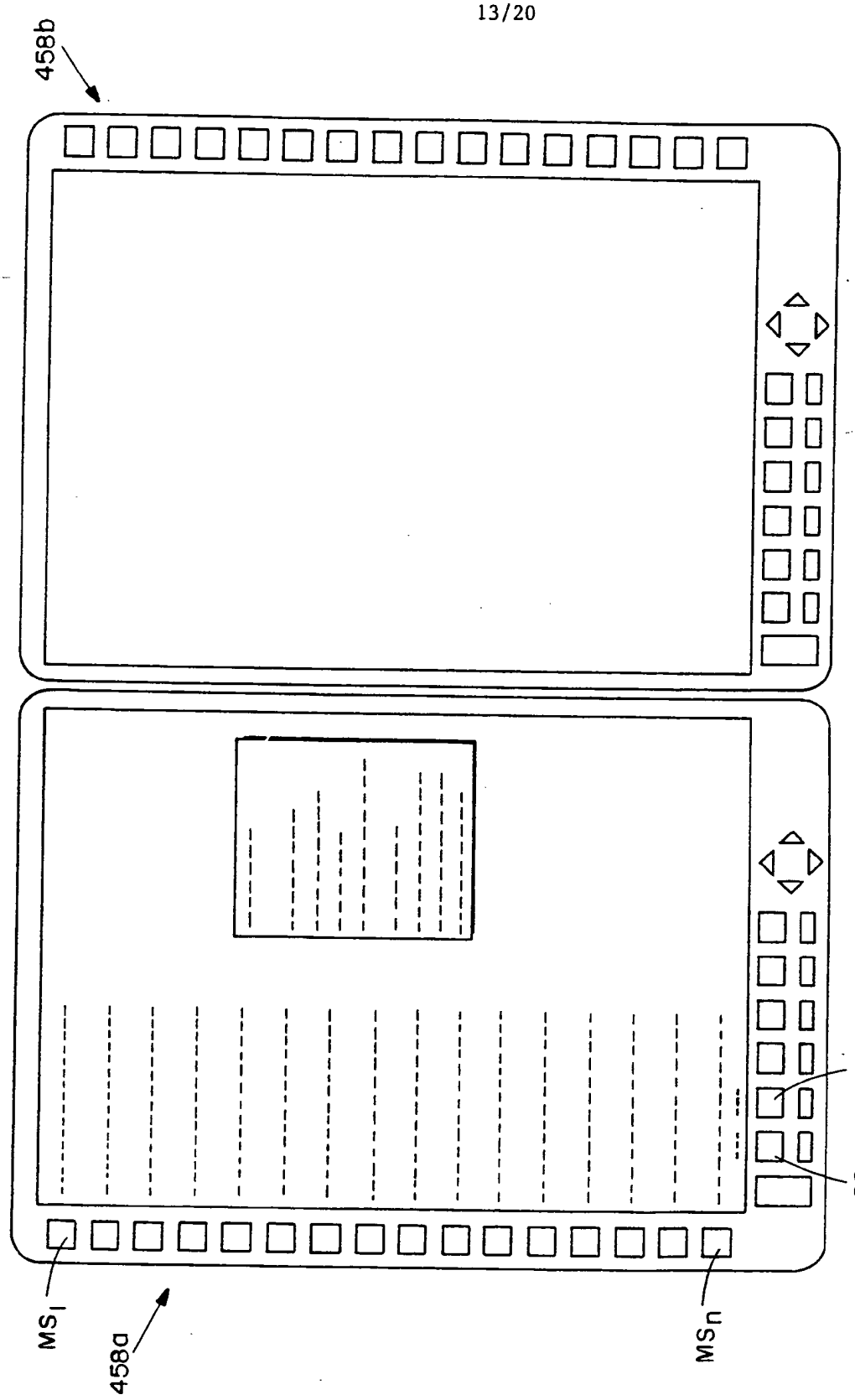

FIG. 8B

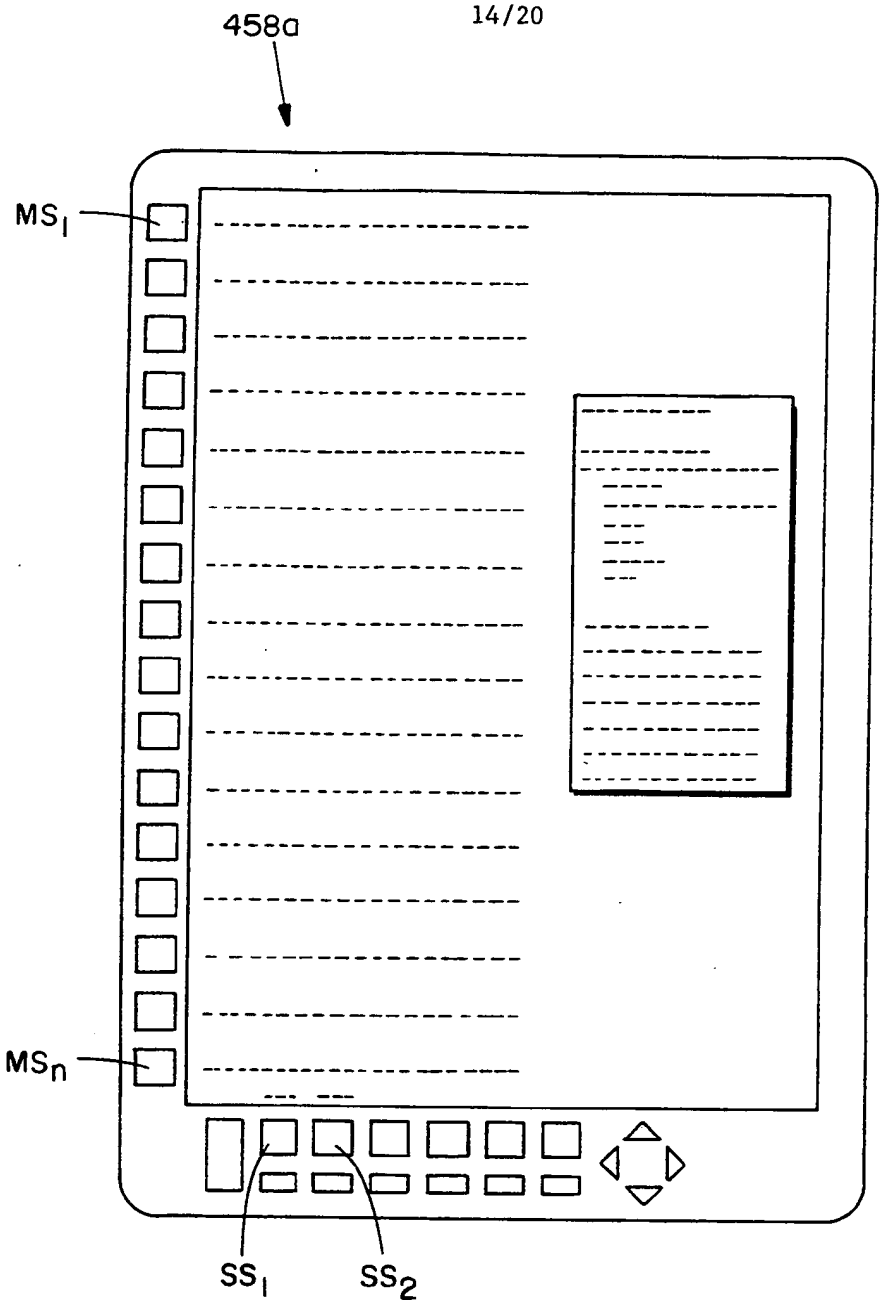

FIG. 9A

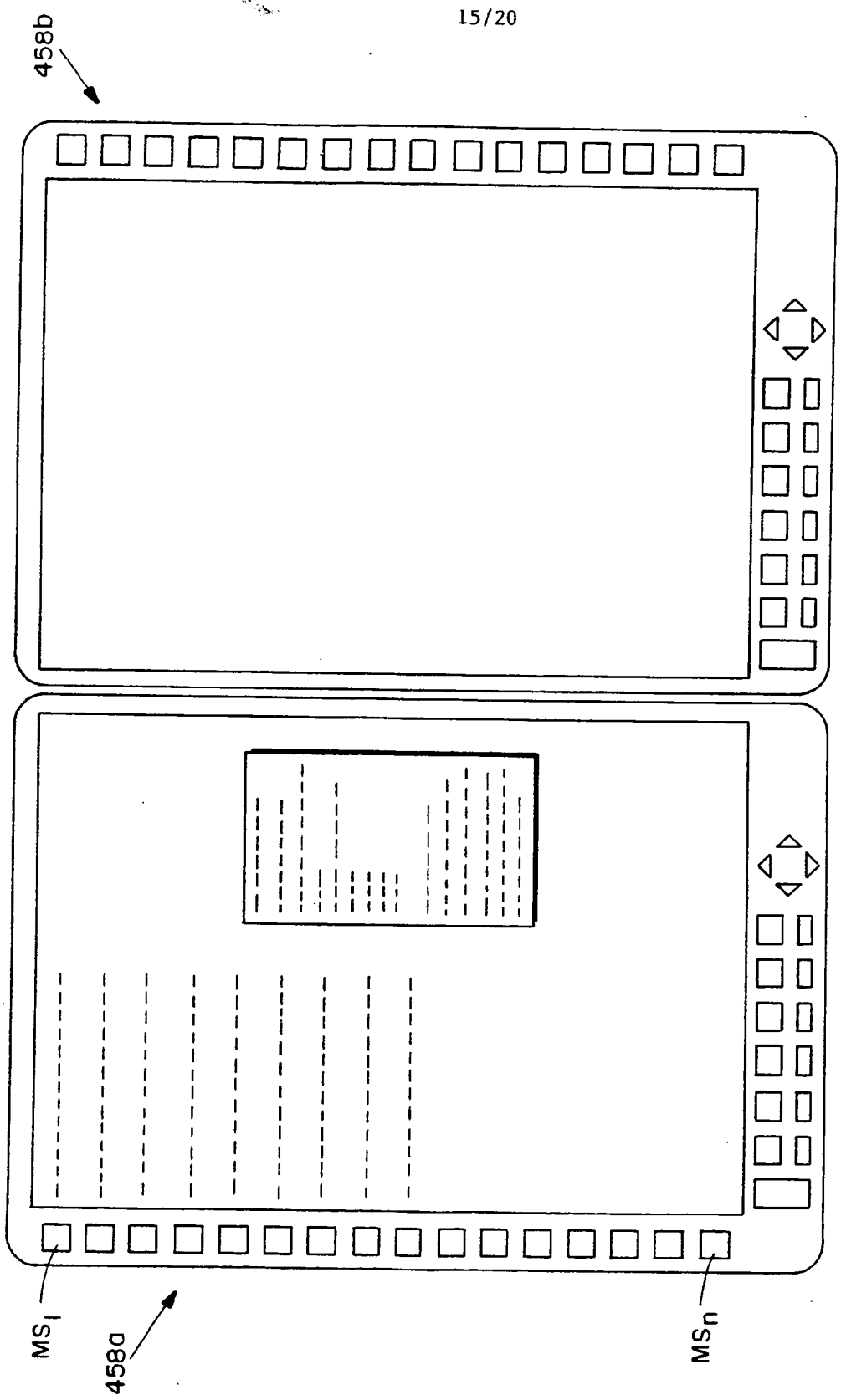

FIG. 9B

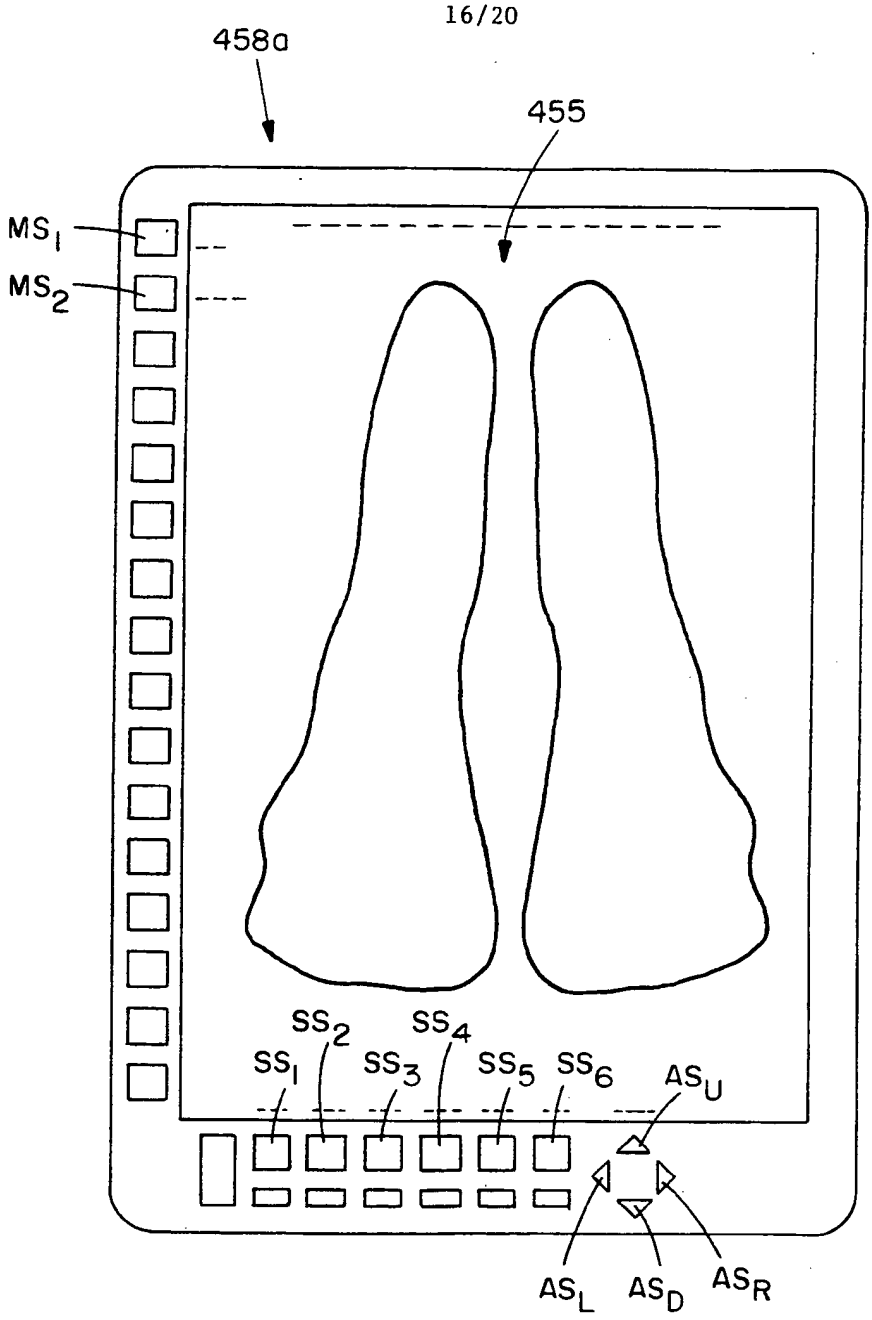

FIG. 10A

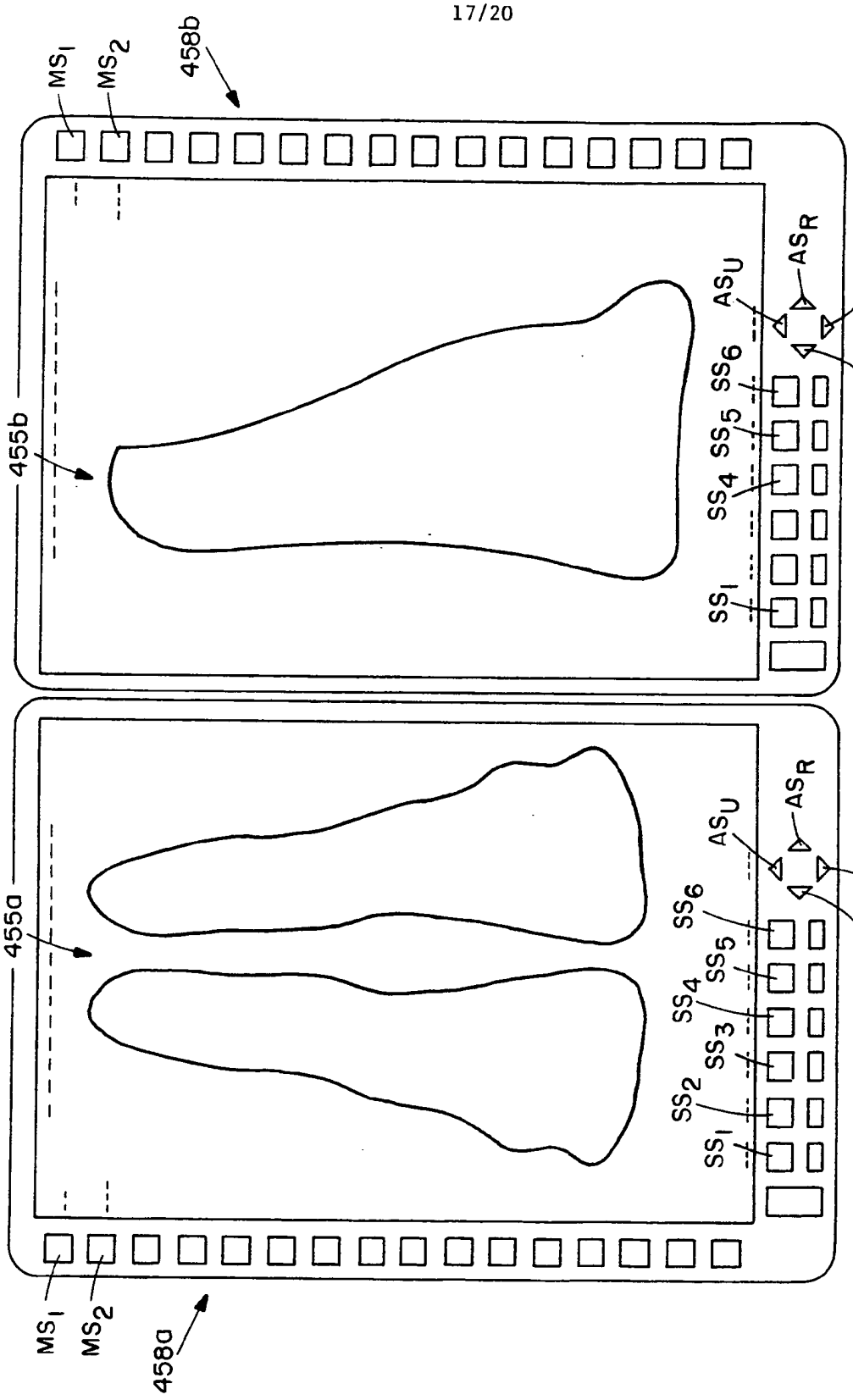
458b
MS1
MS2
455b
ASU
ASR
ASD
ASL
SS6
SS5
SS4
SS1
455a
SS3
SS2
458a

FIG. 10B

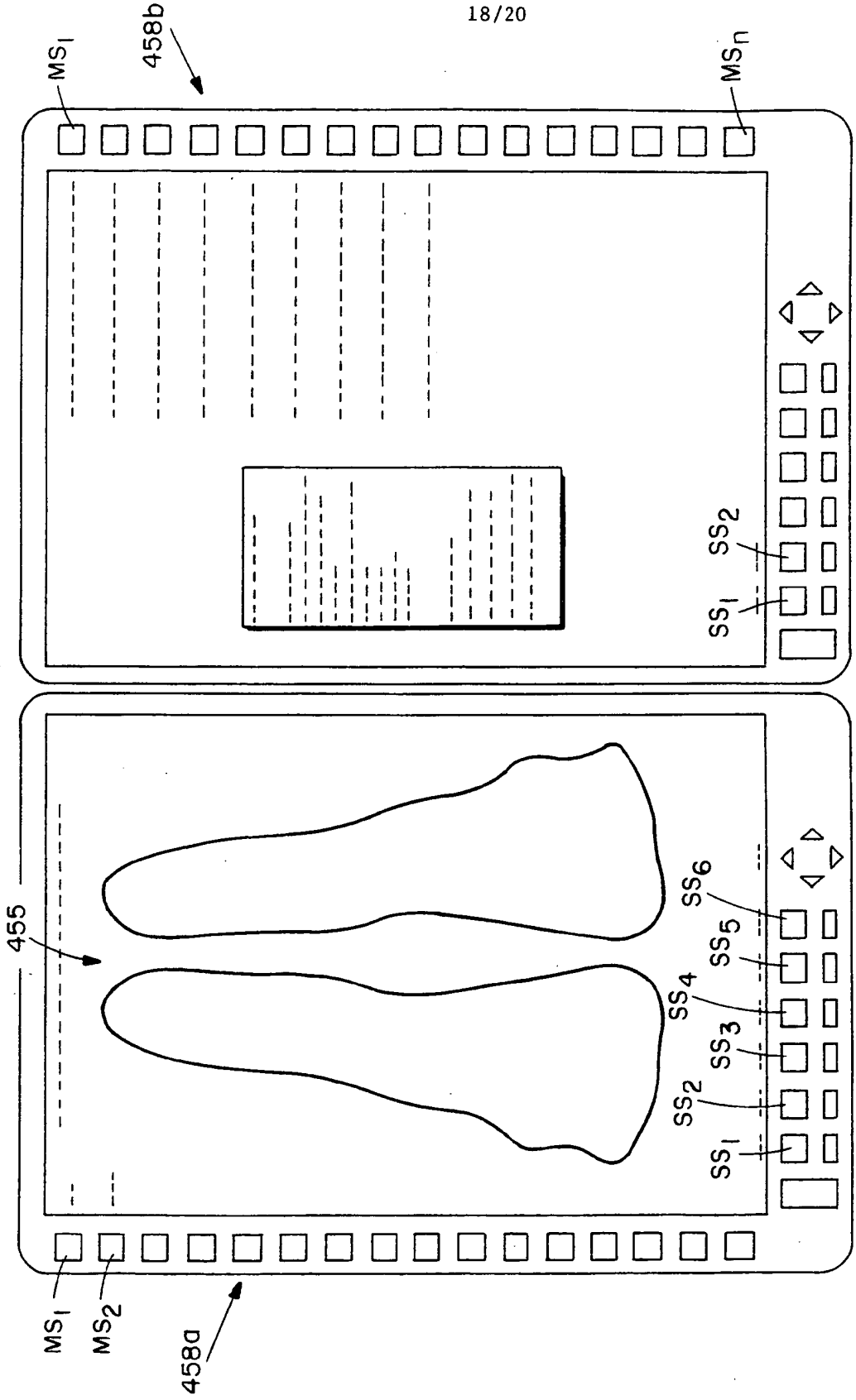

FIG. 11

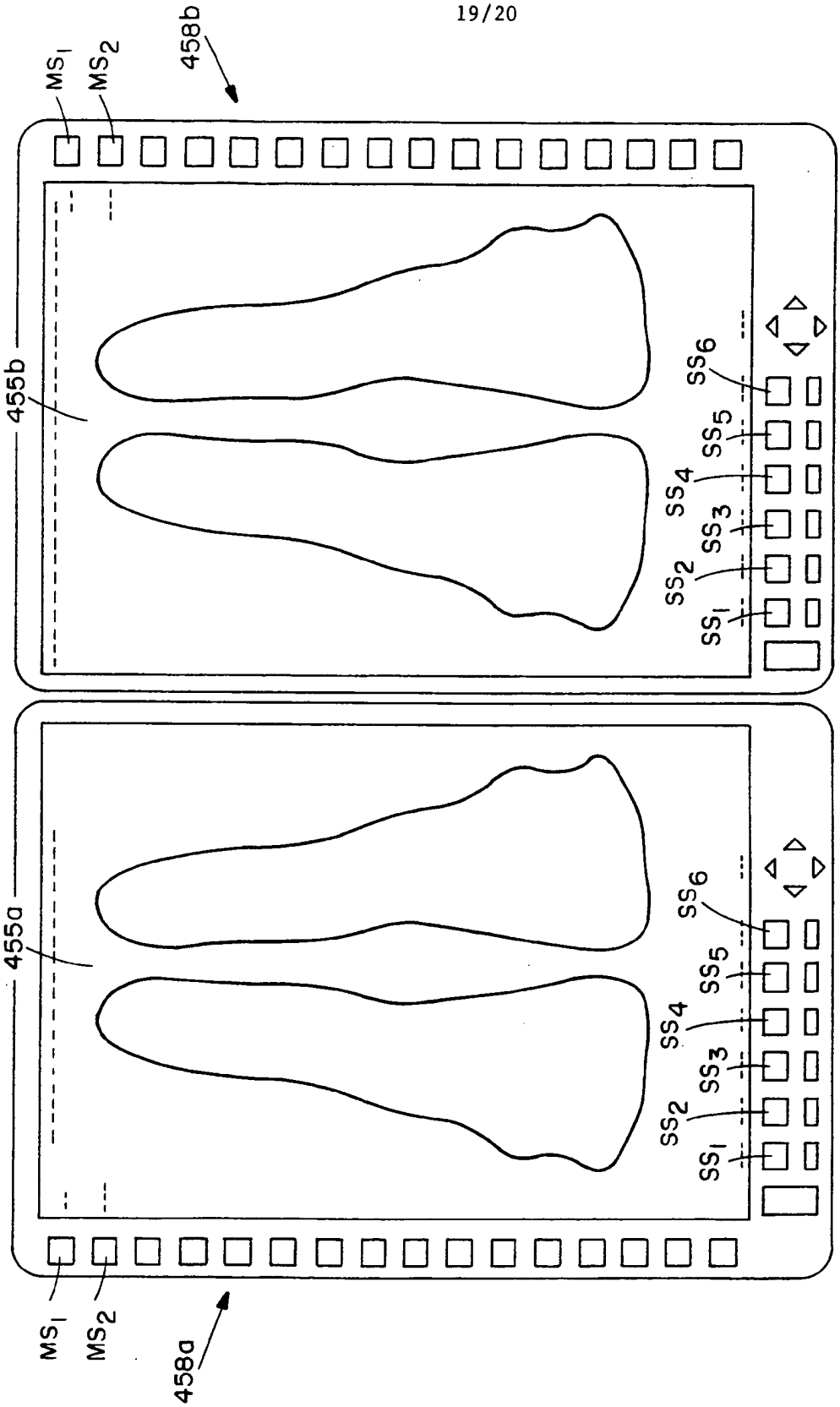

FIG. 12

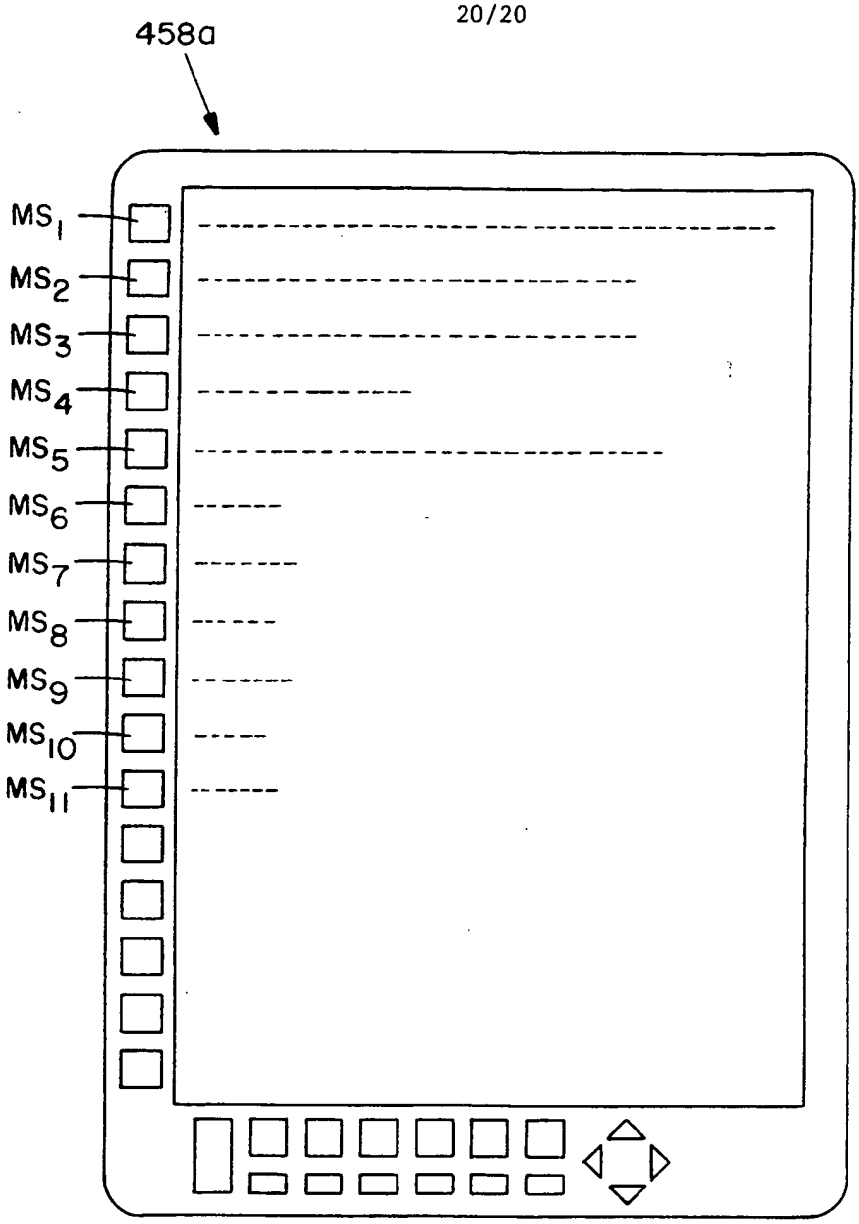

FIG. 13

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(74) Agents: SMITH, James, M. et al.; Hamilton, Brook, Smith & Reynolds, Two Militia Drive, Lexington, MA 02173 (US).

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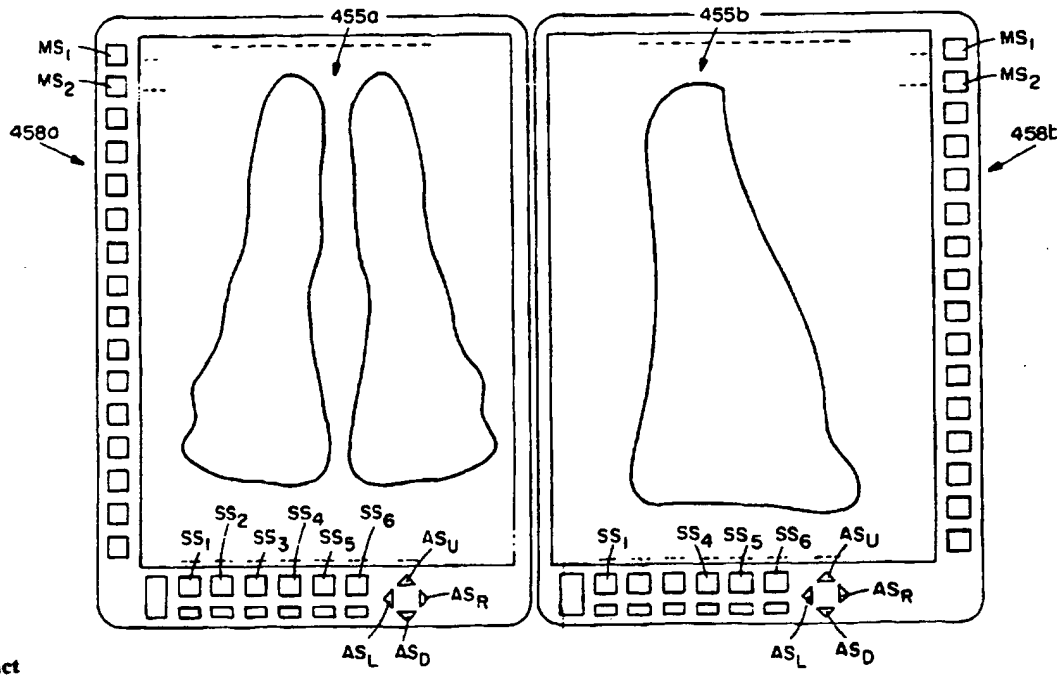
(54) Title: USER INTERFACE FOR PICTURE ARCHIVING AND COMMUNICATION SYSTEM



(57) Abstract

A picture archiving and communication system (PACS) stores, maintains, and displays medical image data for intensive care patients. The system provides rapid access to medical image data so that Intensive Care Unit physicians and radiologist have around-the-clock instant access to medical images. The medical images are displayed on medium or high resolution switch-driven monitors coupled to image review stations. Each image review stations can support up to two monitors, which simultaneously display different images. The display on a first monitor is controlled by touch-sensitive input switches on the first monitor. The display on a second monitor is controlled by the display on the first monitor and touch-sensitive input switches on the second monitor.

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INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/US 93/11384

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 G06F15/42

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 487 110 (KABUSHIKI KAISHA TOSHIBA, JP) 27 May 1992 see column 12, line 18 - line 48 see column 14, line 26 - line 55 see column 18, line 43 - column 19, line 11 ---	1-5,27
P,X	WO,A,92 22874 (BOARD OF REGENTS, THE UNIVERSITY OF TEXAS SYSTEM, US) 23 December 1992 see page 8, line 20 - page 10, line 2 --- -/--	1-5,27

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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2

Date of the actual completion of the international search	Date of mailing of the international search report
20 April 1994	29.07.94
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer BARBA, M

Form PCT/ISA/210 (second sheet) (July 1992)

Intern. al Application No
PCT/US 93/11384

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON COMUNICATIONS BOSTONICC/89, IEEE PRESS NEW YORK US, vol.3/3, 11 June 1989, BOSTON, MA, US pages 1496 - 1500, XP000075397 N.D.GEORGANAS ET AL 'A MULTIMEDIA COMMUNICATIONS SYSTEM FOR MEDICAL APPLICATIONS' see page 1496, right column, line 36 - page 1497, left column, line 5 see page 1499, left column, line 21 - line 52 see figure 3 ---	1-5,27
A	IEEE ENGINEERING IN MEDICINE AND BIOLOGY MAGAZINE, vol.11, no.1, March 1992, NEW YORK US pages 51 - 56, XP000294356 F.BELTRAME ETAL 'INTEGRATED IMAGING FOR NEUROSURGERY' see page 54, left column, line 27 - page 56, left column, line 59 see figures 7,8,9 -----	1-5,27

INTERNATIONAL SEARCH REPORT

. rnational application No.
PCT/US 93/ 11384

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

SEE ANNEXED SHEET

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-6,27

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INVITATION TO PAY ADDITIONAL FEES

International application No.
PCT/US 93/ 11384

1. Claims 1-6,27: Monitor couppled to a radiographic image data processing unit.

2. Claims 7-13,28-33,42-48: Apparatus and method for displaying radiographic images stored in an image data base.

3. Claims 14-26,34-41: System and method for archiving and reviewing radiographic data for a plurality of patients.

Justification

In the present application, SAE 83095, several sets of claims relating to different technical features are disclosed:

1. Independent claim 1 and its dependent claims 2-6 and independent claim 27 describe a monitor coupled to a radiographic image data processing unit.

2. Independent claim 7 and its dependent claims 8-13, and independent claim 28 and its independent claims 29-33 and independent claim 42 and its independent claims 43-48 describe an apparatus and method for displaying radiographic images stored in a image database on a monitor.

3. Independent claim 14 and its dependent claims 15-26 and independent claim 34 and its dependent claims 35-41 describe a system and a method for archiving radiographic data for a plurality of patients.

The in the search report cited EP 487110 patent application describes a monitor coupled to a radiographic image data processing unit comprising a display screen, a monitor housing and a plurality of touch-sensitive input switches.

This yields satisfy the requirements of the claims 1-5 and 27 of the present application and therefor independent claims 1 and 27 of the application doesn't fulfil the requirements of novelty.

There is no common special technical feature, linking independent claim 1 and claims 7, 28, 42, 14, 34. Consequently the application doesn't comply the requirements of unity of invention (see rule 13 PCT).

The search has been performed, according to Art. 17,3 PCT, on those part of the international application which relate to the invention first mentioned in the claims (i.e. claims 1-6, 27).

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern al Application No
PCT/US 93/11384

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0487110	27-05-92	JP-A-	5012352	22-01-93
		US-A-	5235510	10-08-93
WO-A-9222874	23-12-92	US-A-	5179579	12-01-93
		AU-A-	2239092	12-01-93